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PROJECT STATEMENT

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U. S. Department of Agriculture

BUREAU: Bureau of Agricultural Engineering.
BUREAU PROJECT NO.: 18
APPROPRIATION SYMBOL: 1010
PROGRESS REPORTS REQUIRED: Semi-annually.
TITLE: Corn Borer Control Machinery
LEADERS: R. B. Gray, R. M. Merrill, Frank Irons

OBJECTS: To secure optimum control performance from machines and devices which have proved effective in the control of the European corn borer in both the Eastern and Middle Western infestation, and to develop new machines or attachments which show promise. Such work will include the thorough testing in as many conditions as possible machinery and devices which have been developed, in order that the equipment may be safely recommended for general use.

PROCEDURE: Due to reductions in personnel, as much of the field testing of machines and attachments as possible will be carried on by farmers who from previous experience are known to be good cooperators. Certain equipment will be placed in their hands and kept under observation while in use. Field tests which must be more closely controlled will be carried on by our own men.

The results of the development and testing work will be made available to farmers, manufacturers and any others interested as soon as expedient.

The efforts during 1935 will be centered mainly as follows:

1. Plowing. The plowing work will be concentrated on the further improvement of disc jointers and trash guides. These attachments have proved very effective in covering crop residues and the disc jointer in displacing the troublesome moldboard jointer is especially valuable. These attachments will be tried in the field in Ohio, Michigan, Illinois, Indiana, Iowa and New Jersey in different soil conditions. Near Toledo the attachments will be used on both tractor and horse drawn plows. In addition to the general use of the attachments in the hands of farmers sufficient formal tests will be made to determine the draft in different conditions. An effort will be made to interest manufacturers in the production of the attachments.

If preliminary studies now being made on a disc plow designed for high speed plowing show promise this implement will be developed further for use with the modern high speed rubber tire equipped tractor. Heretofore disc plows travelling at

... do not covered trash sufficiently for control purposes but by designing a disc plow for higher speeds and pulling them at these higher speeds it is felt that better coverage will result as well as better pulverization.

2. Harvesting. The combination corn picker and stalk chopper which proved quite successful during the past season will be refined and improved as much as possible. An eight blade cutter head will be installed to replace the six blade cutter now being used. This will cut the stalks in finer pieces and give greater borer mortality. Provision will be made for saving the corn shelled by the snapping rolls and an attempt made to prevent any ears from passing through the cutter head.

If funds permit, a new, lighter weight combination picker chopper machine will be constructed with radically different arrangement of snapping rolls to prevent if possible the waste of shelled corn caused by the conventional arrangement of rolls.

Several low cutting sled corn cutters similar to the cutter developed for New England conditions will be constructed and put in the hands of cooperating farmers. If these sleds prove practical a circular describing their construction will be made available. It is also proposed to develop for New England a simple type sliding knife wheel harvester which should be less in draft and possibly more easily handled than the sled type. Low cutting hand hoes as developed for both Eastern and Western conditions will be followed up and improved as conditions warrant.

In cooperation with the Bureau of Entomology a circular or bulletin will be published to indicate the effectiveness of corn borer control which may be expected with the various methods of harvesting corn in the New England area.

The development of several commercial corn harvesting machines will be followed closely and field tests made on these machines if possible.

3. Insecticide Application. In cooperation with the Bureau of Entomology attempts will be made to improve machinery for effectively spraying growing corn. This work could not be carried on at Toledo during the present season because of damage to the corn by Stewart's disease. This control method has greatest promise in sweet corn, particularly in the East.

COOPERATION: Bureau of Entomology and State of Illinois with informal cooperation by the States of Indiana, Pennsylvania, New Jersey, and Iowa, and interested farmers and implement and machinery manufacturers.

LOCATION: Ohio, Michigan, Pennsylvania, Illinois, the New England States, New Jersey, and Virginia.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, 1935, \$17,000
Cooperators, \$ 7,000

HISTORY: The European corn borer was discovered in North America in the summer of 1917 in the vicinity of Boston, Massachusetts. The most seriously infested areas now are in New York, Pennsylvania, Ohio, Indiana, Michigan, New England, and Ontario, Canada. Approximately 250,000 square miles are known to be infested in this territory in the United States. At present the only known method of controlling the corn borer is by mechanical means.

During the first few years of the development work on mechanical control methods, burning of standing stalks in the field was considered a positive control. Consequently, a flexible hood type of mobile burner was worked out and effective results obtained. However, because of the high initial expense and the high operating costs compared to other control measures and machinery later developed, the burning scheme has been abandoned.

Improvements in the coverage of corn crop debris by plows have been made but further refinements on plows and further development work on attachments is necessary. The trash guide attachment for guiding the stalks under the turning furrow was a recent outstanding development. A public patent has now been secured for it. To still further improve coverage a self angling disc jointer to be used in connection with the trash guide attachment has been developed.

Two types of sled shavers for the low cutting of stalks from which the corn has been picked have been developed. The same idea has been incorporated into a sled-type corn harvester, which requires further development. A type of low-cutting hand hoe for use in New England has been developed and can now be bought on the market.

A special four-bar side delivery rake for the clean raking of shaved stalks into windrows has been developed and several of these have been "farmed out" with excellent performance records to their credit.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering
BUREAU PROJECT NO.: 1
APPROPRIATION SYMBOLS: 2113 to 2115
PROGRESS REPORTS REQUIRED: January and July
TITLE: Run-off Investigations
LEADERS: Lewis A. Jones, C. E. Ramser, D. L. Yarnell.
OBJECTS: The objects of this project are:

(1) To determine the necessary capacities of open ditches and tile drains for the drainage of land for agriculture, and to prevent injury by overflow of the land.

(2) To measure the effect of various influences that retard the flow in drainage channels and thereby to determine more accurately the values of the empirical coefficients used in hydraulic formulas, or to devise a new formula should that be more practical.

(3) To study the problems of erosion and silting in drainage ditches and natural water courses.

The required capacity of drainage channels depends upon the amount and distribution of the precipitation, and upon the size, shape, topography, soils and vegetation of the drainage basin. This investigation will include determinations of rainfall and snowfall for particular drainage basins; the rates of flow in drainage channels, natural or artificial, particularly the maximum rates; the percentage of precipitation that appears as runoff, and the duration of floods; and the amount of storage in lakes, ponds and watercourses, which might be affected by drainage of the land.

Flow of water in an open channel is caused by the slope of the water surface, and is retarded by friction against the sides and bottom of the channel, impact against bends and obstructions, and internal friction due to the eddies caused by large and small irregularities in the slope, size, shape, and alignment of the channel and in the surface of contact with the water. The effect of these separate influences have not been measured with satisfactory accuracy. A better formula or more exact coefficients for existing formulas will enable the capacities of channels to be computed more accurately and the effect of proposed drainage improvements to be predetermined with more certainty.

The capacity of a stream to transport material varies with the 2.5 power of the velocity (according to Kennedy), and is also a function of the depth. Erosion in a channel will be retarded or prevented by the cohesion of the material forming the sides and bottom of the channel, or by a large portion of particles heavier than can be picked up by the velocity at the perimeter of the stream. Silting with reduction in velocity can be avoided only if the suspended material already is less than the stream's capacity at the reduced velocity, or probably by changing the dimensions of the channel and reducing the depth of flow. Much more data than are now available must be secured regarding the amount of erosion and silting under known conditions of velocity of water, kind of channel, and character of sediment, before it will be possible to forecast the nature and cost of maintenance for many drainage ditches.

PROCEDURE: Measurements of flow in open drainage ditches will be made with current meters at various stages, and from these ratings curves will be prepared for the determination of flows at other stages. Continuous records of the depth of flow in the channels will be secured by automatic recording instruments. Records of rainfall will be kept. Detailed information will be secured concerning the size and physical characteristics of the drainage areas, from topographic maps, soil survey reports, and other maps and reports that may be available, supplemented by thorough inspections and by surveys where necessary to secure accurate information.

On channels where run-off measurements are being made, experimental courses will be selected representative of good and bad conditions regarding bends, obstructions, regularity of cross-section, uniformity of grade, roughness of banks, and vegetation in the channel. Measurements and other descriptive notes will be made, including photographs, to record most accurately the conditions affecting the experiments. To determine the slope of the water surface, bench marks and gage stakes have been set at each end of the experimental course and connected by precise leveling. Each course has been accurately cross-sectioned and current meter measurements of velocity will be made. Thus the quantity of flow is determined and the mean velocity for various states from minimum to maximum, and the corresponding values of the hydraulic coefficients are computed. Where practical, after coefficient measurements for a channel in poor condition have been made, vegetation and other obstructions are removed and further measurements of the coefficients are made, which permits more direct determination of the effect of separate factors in retarding flow.

The thorough investigation of erosion and silting requires that channels in which such action is occurring be studied with respect to velocity of flow, cross-section of the stream, character of sediment deposited, material of which the channel is formed, and cohesion between the particles, and the amount of material deposited and carried away. The material transported will be analyzed according to weight and size of particles the quantity will be measured by taking samples of the water. A method of measuring the cohesion of soils or expressing the relative resistance to erosion is yet to be developed. Plans have not been completed for an extended investigation of this subject.

During the fiscal year 1935 the investigations will be continued on the Ralston Creek watershed in Iowa and the watersheds being studied in northern Minnesota and in the vicinity of the soil erosion experiment farms. The report covering the work in the vicinity of Bowling Green, Ohio, is about 90 per cent completed. This report will be finished.

COOPERATION: University of Iowa; Minnesota State Department of Conservation.

LOCATION: Iowa City, Iowa; Northern Minnesota.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering 1935.

PROPOSED EXPENDITURES: Anticipated expenditures for fiscal year 1934:

Bureau of Agricultural Engineering	\$1,000
University of Iowa	150
Minnesota State Department of Drainage and Waters	400

HISTORY: Studies of the hydraulics of drainage channels and records of run-off have been made by the Bureau since 1913 in northwestern Mississippi, western Tennessee, western Illinois, and eastern Indiana. Results of the determinations of roughness coefficient in Kutter's formula have been published in Department Bulletin No. 832 (1920), and in Technical Bulletin No. 129 (1929). Most of the data relating to rates of run-off have been made available in mimeograph form, though a sufficient number of conditions have not yet been covered to warrant publishing a formula or rules for estimating rates of run-off that drains should be designed to carry. The investigations of erosion and silting in channels have been, so far, incidental examinations of individual cases.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering
BUREAU PROJECT NO.: 19
APPROPRIATION SYMBOL: 1020
PROGRESS REPORTS REQUIRED: Semi-annually
TITLE: Fertilizer Distributing Machinery.
LEADERS: R. B. Gray, G. A. Cumings, A. L. Sharp, W. H. Redit.

OBJECTS: To secure information which will aid in the designing of more efficient fertilizer distributing machinery and establishing safer and more effective methods of applying fertilizer to various crops, such as cotton, corn, potatoes, sugar beets, tobacco, both snap and lima beans, and canning crops.

To test and observe the performance of certain commercial distributors and newly developed devices and attachments, under both field and controlled laboratory conditions.

To develop improved distributors particularly adapted to experimental work with fertilizers.

To determine the most economical and practical corrosion resistant material, coating or treatment for prolonging the life of the various parts of fertilizer dispensing mechanisms.

PROCEDURE: Cooperative fertilizer placement experiments with various crops will be conducted as follows:

1. Cotton: At 13 locations in North Carolina, South Carolina, Georgia, Mississippi, Louisiana, Texas and Oklahoma a fertilizer of ordinary analysis will be applied.
 - a. At a standard rate in 14 different positions with respect to the seed at time of planting.
 - b. At three different rates in each of three placements at time of planting.
 - c. At the standard rate in three placements and "bedded on" ten days before planting.
 - d. At time of planting, on land bedded 10 days before planting.
 - e. In both acid and neutral form, in two placements.

Some inferior placements previously found to be inferior will be eliminated and additional placements will be included. "Bedding on" fertilizer in advance of planting, a prevailing farm practice, is a new phase of the project, included to compare effects of fertilizer according to time of application. Effects of acid and neutral fertilizers is a new problem in the production of crops on sandy soils.

2. Potatoes: At 7 locations in Virginia, New Jersey, New York, Maine, Ohio, and Michigan, both ordinary and high analysis fertilizers will be applied at equivalent rates in 7 representative placements with respect to the seed piece. Acid and neutral fertilizers will also be applied at certain locations. Study has been in progress two years.

3. Tobacco: At one location in each of the States, Maryland, North Carolina, South Carolina and Georgia, both ordinary and high analysis fertilizers will be applied in five representative positions with respect to the root crown of the plant. Study has been in progress one year.

4. Snap Beans: At four locations on the East Coast of Florida, ordinary and high analysis fertilizer will be applied on bedded land in approximately six placements with respect to the seed. Projects in Central Florida have been in progress three years and will be discontinued because of the urgent need of information for the Eastern Coast conditions.

5. Lima Beans: At Norfolk and Onley, Virginia, ordinary fertilizer will be applied in approximately 15 placements including prevailing local practices. Study has been in progress one year.

6. Sugar Beets: At several locations in Colorado, Nebraska and Michigan, fertilizer will be applied in five placements. Superphosphate will be used in the Western experiments at approximately 150 pounds per acre. New studies will be inaugurated in Michigan in which mixed fertilizer at 600 pounds per acre will be applied.

7. Canning crops, including corn, peas, beans, beets, tomatoes and cabbage: At Geneva, New York, for the first time an ordinary fertilizer will be applied in at least six different positions with respect to the seed or plant for each of five crops grown in a rotation system. The object is to measure the accumulative effect of fertilizer placement including broadcast.

These experiments will be repeated annually without material change for several years to obtain representative conditions of soil and weather. At such times as changes in the plans seem justified, each experiment will be reorganized and the new line of investigation

will be started for another period of three to five years. Recommendations cannot be safely made unless an experiment of this kind is repeated a number of times under normal variations of weather.

The fertilizers will be prepared and the observations to determine the effects of the various placements will be made by cooperating parties.

The cooperators will measure the effects of fertilizers on rapidity and uniformity of germination of the seed, early plant growth, blooming period, time of maturity and yields under the various conditions of application. Cooperators will also make arrangements for the land required and will make such determinations on the soil as may seem necessary.

Special combination planters and fertilizer distributors and attachments will be designed and constructed to meet the requirements of the fertilizer placement studies. Several planters, including three for cotton, two for beans, two for potatoes, and one tobacco transplanter have been constructed or rebuilt and equipped with the revolving-cylinder top-delivery type of fertilizer hopper. Suitable adjustments have been provided by which the fertilizers can be placed in any one of several placements with respect to the seed. The experimental machines require alteration from year to year for improvement and to meet the changing requirements of the field studies. In addition to satisfying the various conditions of the experiments, the distributors must meet the following requirements: positive dispensing action with convenient and accurate delivery rate adjustments, uniform distribution of the fertilizer, and no material variations as a result of changes in operating conditions.

In addition to altering the machines on hand, it will be necessary to provide a special two-row sugar beet drill, a drill for peas and beets and a fertilizer broadcasting machine.

Representative types of commercial distributors and attachments will be tested in the field and laboratory as time permits as follows:

1. Each machine, for various states of fertilizer drillability and at various delivery rates, will be tested in the laboratory to determine the following:
 - a. Range of delivery rates.
 - b. Increments of delivery rates possible.
 - c. Accuracy of delivery rate adjustments.
 - d. Possible variations in delivery rate at a particular control setting.

- e. Accuracy of maintaining delivery rates.
 - f. Uniformity of fertilizer distribution.
 - g. Effect of forward and rearward inclination on delivery rate.
 - h. Effect of lateral inclination on delivery rate.
 - i. Effect of depth of fertilizer in the hopper on delivery rate.
 - j. Segregation of the fertilizer particles.
 - k. Effect of speed on delivery rate.
 - l. Power requirements.
 - m. Extent of clogging and bridging of the fertilizer.
 - n. Efficiency of agitators.
 - o. Susceptibility to corrosion.
2. Each complete machine unit will be tested in the field on representative soil types and under different seed bed conditions, for the following:
- a. Placement of the fertilizer in the soil.
 - b. Ease of guiding, handling and general manipulation.
 - c. Efficiency and difficulties with furrow openers, coverers, depth gages, press wheels, depositors, hilling attachments, levelers and other attachments.
 - d. Blowing of fertilizer from the hopper and tubes.
 - e. Ease of emptying and cleaning the hopper.
 - f. Draft.
 - g. Wheel slippage.
 - h. Convenience and accuracy of adjustments.
 - i. General operating characteristics.

Information will be obtained on corrosion resistant metals, and coatings now on the market. Comparative tests of specimens of corrosion-resistant metals suitable for use in the construction of fertilizer distributors may be made by exposing them to representative fertilizer samples, over a considerable period of time.

Development of machines and attachments to obtain accurate distribution and proper placement of fertilizers will be undertaken when the experimental evidence justifies final conclusions, providing the manufacturers have not undertaken such developments. To date some manufacturers have followed the experimental work closely and have made improvements in machines as rapidly as justified by the experimental results.

Sub-projects with cooperative agreements pertaining to the different phases of the study will be organized under the general project.

COOPERATION: Bureau of Chemistry and Soils, Bureau of Plant Industry, Joint Committee on Fertilizer Application, State Agricultural Experiment Stations, and the National Fertilizer Association.

LOCATION: Representative areas for the crops to be studied including locations in Colorado, Florida, Georgia, Louisiana, Maine, Maryland, Michigan, Mississippi, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, South Carolina, Texas and Virginia.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$17,000
Cooperators, 5,500

HISTORY: Insufficient information on different methods of applying fertilizers to various crops under the various conditions is available to serve as a basis for the proper design and construction of distributing machinery. The commercial machines on the market do not meet the special requirements of experimental work. Field experiments designed to determine the most advantageous placement of the fertilizer with respect to the seed for cotton were stated on a small scale in 1930 and expanded into eight states in 1931. Similar work with potatoes in five states, tobacco in four states, lima beans in one state, snap beans in one state, and sugar beets in two states was in progress in 1934. Because of the numerous conditions and ramifications involved only certain phases of the problem can be studied during any particular period. Even for a limited set of conditions several years results are considered necessary for reliable indications. To study the problem thoroughly and adequately for a particular crop, a period of ten or fifteen years may be required. With the introduction of additional crops into the study from time to time, the duration of the projects is uncertain and might be considered more or less permanent. It is proposed for the coming year to continue the 1934 experiments with certain desirable changes and reductions and to conduct additional fertilizer placement experiments with sugar beets in Michigan, and with canning crops and potatoes in New York.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.
BUREAU PROJECT NO.: 7
APPROPRIATION SYMBOL: 2151
PROGRESS REPORTS REQUIRED: January and July.
TITLE: Drainage District Operation.
LEADERS: Lewis A. Jones and John G. Sutton

OBJECT: To make a broad study of all the operations of drainage districts in order to determine why some have failed while others have prospered and what effect the various conditions of organization and operation have toward the success or failure of the enterprise.

From an analysis of the circumstances attending the organization of drainage districts, the construction of the improvement works, and the development of the lands, a report will be prepared that will help to guide not only persons contemplating the promotion of new drainage enterprises but also those interested in the management of existing districts. Such a report will serve also to discourage the organization of unwise or untimely projects that are certain to result in loss to all concerned.

PROCEDURE: Drainage districts may fail physically in not providing sufficient drainage, or financially in not meeting payments due on bonds or other indebtedness. It appears that failure may be due to faulty design or construction of the drainage works, to inadequate maintenance of the works after construction, to cost of drainage in excess of the earning power of the land, to lack of settlers for developing and farming the land, to excessive charges in organizing and financing the district, to poor administrative management subsequent to organization, or to physical or other causes outside of or independent of the district.

A detailed study will be made of the history and present status of a representative number of districts in each of a number of States, illustrative of different methods of organization and of financing. Both successful and unsuccessful districts will be examined. They will be so selected that comparisons can be made as to character of lands, amount of drainage provided, nature of the drainage works, costs of drainage, and agricultural conditions. In order that fairly complete information may be obtained, particularly as to crop yields and acreages in crops in the early years of development, and that prices for construction and other factors may be comparable, choice of the districts to be examined in detail will be limited to those organized within the last 10 or 15 years.

Concerning each district particularly studied data will be obtained as to:

1. Condition of lands before drainage.
2. Statute under which organized.
3. Plan of drainage - estimated cost.
4. Drainage achieved - adequacy of plan.
5. Adequacy of maintenance.
6. Costs for installation and for maintenance - classified.
7. Financial organization, practices, and costs.

Concerning a representative number of farms in each district studied, information will be obtained as to:

1. Private drains to supplement district works.
2. Increases in crop acreage and in crop yields.
3. Other changes in use of lands.
4. Increases in land values and in farm income.
5. Drainage taxes paid.
6. Delinquencies in payments of drainage and other taxes.
7. Land ownership.

Information will be collected also for comparing conditions inside and outside the drainage districts, and as to such tangible benefits as health and convenience.

Most of the data concerning each district are obtainable from the records of the district or the county, as are those relating to taxes assessed or paid. A considerable part of the information concerning the individual farms, and of the general development in the district, must be compiled from statements to be secured from the farmers and from other persons who know the conditions.

This project was started during the fiscal year 1932 and the data outlined above was secured for a considerable number of drainage districts in various parts of the country. The work during the fiscal year 1935 will be devoted primarily to the compilation and analysis of the data already collected and to the supplementing of the data by additional field studies, should such procedure seem desirable.

COOPERATION: None.

LOCATION: Illinois, Iowa, Minnesota, Mississippi, and perhaps other central and southeastern States.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures for the fiscal year 1935, \$3,000.00.

HISTORY: Though there are many successful drainage districts in many States, in most if not all of the States some districts have failed in either the physical or financial sense. Districts that fail to meet their financial obligations receive more publicity than those that succeed, the effect of which is to depress the price of bonds issued by all districts without regard to the soundness of the individual enterprises. No investigations to disclose the reasons for the failure of drainage districts have been undertaken by either State or Federal agencies. An investigation and report by Mr. R. D. Marsden and Mr. R. P. Teele, on "Economic Status of Drainage Districts in the South in 1926", deals with land settlement practices and the agricultural and financial status of the enterprises but does not discuss the organization and internal operation of the districts.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 3

APPROPRIATION SYMBOL: 2132

PROGRESS REPORTS REQUIRED: January and July.

TITLE: Effect of Soil Alkalies, Soil Acids and Frost on Clay and Concrete Drain Tile and Remedial Measures.

LEADERS: Lewis A. Jones, D. G. Miller.

OBJECTS: To determine the factors that influence the permanency of under drains, because of failures of the structural material used, as a result of chemical and frost action.

(a) To determine the effect of soil alkalies upon drain tile, both clay and concrete; to develop methods and processes for making concrete tile that are more resistant to the action of soil alkalies than are those now in use; and to determine, when expedient, those areas where commercial concrete tile, as now manufactured, can be safely used.

(b) To determine the effect of peat and muck soils and of certain acid soils on clay and concrete drain tile and to develop methods and processes of making concrete tile that are immune, or more resistant, to action of these types of soil than are those tile now in use.

(c) To determine the effect of frost action on drain tile, both clay and concrete, with the primary object of encouraging, in all practicable ways, the manufacture, sale and use only of frost resistant tile in those localities where it is common practice to install tile systems well above the frost line.

PROCEDURE: During the fiscal year 1935 work on the concrete alkali phases will include the routine testing of experimental cylinders from Medicine Lake, South Dakota, that have been subject to exposure for periods ranging up to twelve years. Investigations will be continued aimed at the development of a short time test for determining the alkali resistance of a Portland cement. We have run some experiments along this line and have some leads that look promising. Curing tests will be continued to obtain more exact information of the effect of high temperature steam curing on the strength of concrete. Additional work will also be done with certain admixtures, particularly when used in concrete cured in steam temperatures comparable with those now in use at many concrete products plants, i.e. 125° - 135° F. The use of a 2 per cent calcium chloride admixture in concrete cured

at 130° F. has resulted in a highly resistant concrete, which is one of the outstanding results so far secured on the project. It opens up a whole new field for experimentation with other admixtures in concrete products cured at relatively high temperatures.

Plans for the concrete-peat work, which has been under way since July 1925 will consist of the preparation of a progress report based on tests at one, three, and five years of cylinders of concrete and mortar from fifty groups installed in peat in six locations. Plans are not being made to extend the concrete-peat work as it is anticipated that completion of tests of the fifty types of concrete now under observation will make it possible to bring the project to a reasonably satisfactory conclusion.

COOPERATION: University of Minnesota, Minnesota State Department of Conservation, University of Wisconsin, and tile manufacturers of Iowa, Minnesota, South Dakota and Wisconsin.

LOCATION: University Farm, Saint Paul, Minnesota, with field work in Minnesota, Iowa, North Dakota, South Dakota, and Wisconsin.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures of funds from all sources for fiscal year 1935:

U. S. Department of Agriculture	\$4,700
University of Minnesota	1,500
Minnesota State Department of Conservation	1,565

HISTORY: Necessity for this project developed during the spring of 1919 when drain tile, upward in diameters to 30 inches, were discovered to have failed following periods of service of but a few months in public ditches of southwestern Minnesota. At a conference of representatives of this Bureau, the Bureau of Standards, the Portland Cement Association, and certain state college and county officials, the Bureau agreed to make the necessary investigations to determine the causes of failure in view of the very great economic significance that the failures portended to Minnesota and to a number of western states having alkali areas to be drained. At the time these failures were first noted, Minnesota alone had already installed in public ditches nearly 6,000 miles of tile at a cost of more than \$6,000,000. Many of these tile were of concrete and of large diameter. Field work was begun September 1, 1919 and following the earlier examination a laboratory was co-operatively established at University Farm, St. Paul, Minnesota, with funds made available July 1, 1921 by an appropriation of the Minnesota State Legislature, in order better to study the problem.

Studies of the action on drain tile of certain acid mineral soils and of peat and muck have a particular bearing on the drainage of many parts of large areas of the upper Mississippi Valley and the coastal regions of southeastern United States. Failures of drain tile in such soils have been reported by a number of reputable observers. During the summers of 1923-1925 representa-

tives of this Bureau and of the Department of Agricultural Engineering of the University of Wisconsin examined drain tile laid in Wisconsin peat and found more or less evident deleterious action on concrete tile in many of the systems, indicating a real need for complete information as to causes and preventive measures.

The use of poor quality clay tile in Minnesota has been followed, in a number of instances, by losses of considerable magnitude because of failure of the tile, through frost action, after but a few years of service. There are no exact figures available to show the extent of such losses but in the aggregate the total is large. The same conditions exist, to a greater or less degree, in others of the more northern states and justify studies in the effort to minimize such losses.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering
BUREAU PROJECT NO.: 21
APPROPRIATION SYMBOL: 1040
PROGRESS REPORTS REQUIRED: July and January
TITLE: Cotton Production Machinery
LEADERS: R. B. Gray, J. W. Randolph, I. F. Reed.

OBJECTS: 1. To determine the fundamental requirements which mechanical equipment must have for efficient production of cotton on principal soils of the Southeastern States.

2. To determine with selected soils and under controlled conditions the force reactions affecting the design of tillage machinery or parts thereof.

3. To study the instantaneous physical effects and their permanency produced by a machine upon a soil as influenced by the soils inherent characteristics, natural agencies and subsequent machine operations.

4. The ultimate objectives are to lower the cost of cotton production, and to aid in the attainment of a permanent profitable farm program for the Southeastern States through the development of machines and methods which will permit the growth of diversified crops with the stable efficient use of labor.

PROCEDURE: 1. Cotton production machinery experiments are to be conducted to determine the ecological and economical effects produced by:

a. Methods of seed bed preparation.

Plots will be prepared using different machines and combinations of machines in the different seasons and with predetermined soil conditions. Each combination will be evaluated on the basis of stand and production of cotton plus weed control obtained.

b. Methods of planting.

Studies will be made to determine the effects on stand and yield due to different methods of seed placements with different conditions of seed beds on several dates.

c. Methods of cultivation.

Different types of cultivating equipment will be used at various intervals to determine their effects on weed control and crop production.

2. Power and tilth studies are to be made in connection with the Bureau's field experiments and with cooperating farmers. The results of this work are to be expressed in pounds of cotton per horse power hour. These basic units and their relationship to the requirements of other crops are a part of the fundamental foundation for the establishment of permanent agricultural system.

3. Study existing equipment to obtain information for improving its performance.

4. Study plows and other tillage equipment under the controlled semi-field conditions afforded by the plots and equipment provided in connection with the Farm Tillage Machinery Laboratory.

COOPERATION: The Alabama and Mississippi State Agricultural Experiment Stations: informal, Farm machinery and equipment manufacturers and interested farmers.

LOCATION: Permanent fields at Prattville, Alabama, West Point and Stoneville, Mississippi, and laboratory investigations at Auburn, Alabama, and Starkville, Mississippi.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$11,000
Cooperators, \$ 3,500

HISTORY: Cotton is the principal cash crop of the Southeastern States. As a result of the normal limiting of cotton produced per man with the present governmental control of agriculture the comparative income per man is still very low. The inability of conventional mechanical equipment and methods to handle soils of many areas, notably the black belt of Alabama and Mississippi which have topography well adapted for cultivation with profitable size units, has resulted in a partial abandonment of these rich fertile areas and the location of the farmers on the eroded and poorly productive hill areas.

The organization of a farm crop program based upon the needs of the family and the new national crop control laws, the farmer is handicapped in that his cotton field operations conflict with other crops as to the time of planting, early cultivation and harvesting. It is evident that the greatest hopes of the individual farmer lies in growing the food and feed necessary for the farm and in producing cotton and other cash crops with the lowest possible costs. This means that the farmer must have machinery and methods which will reduce the overlapping of labor requirements in his balanced crop program. Furthermore on the entire program it is necessary that the usual small-scale methods in which labor, power and machinery represent approximately two-thirds of the expense, be replaced with more efficient methods.

The introduction of machine methods in the cotton-growing areas where hand labor methods have been extensively followed for many years, involves numerous farm machinery problems not only as to use, adaptability, and economic farm practices, but also as to the development of many basic requirements of farm machines to meet the needs of the cotton farmer in the carrying out of an economical and efficient farm program, and to provide the implement industry with basic facts regarding the requirements and principles upon which more efficient and economical farm machines may be designed.

The results on this project have shown that many accepted field practices are without basis or scientific support. Faulty designs of several machines and unwise use of others are largely responsible for their non-profit use. On the other hand, it has been proven that certain machine utilization increased the yield and reduced the unit cost. Through the use of new methods it has been demonstrated that ample time would be released for the growing of other crops. A new system of variable depth cotton planting has been developed which practically insures a good stand of cotton regardless of weather conditions. Several improvements have been made in the design of cotton production machinery that makes them more serviceable and efficient in their operation.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering
BUREAU PROJECT NO.: 22
APPROPRIATION SYMBOL: 1060
PROGRESS REPORTS REQUIRED: March
TITLE: Corn Production Machinery Investigations
LEADERS: R. B. Gray and C. K. Shedd
OBJECTS: To make an analytical study of methods and machinery for corn production with the following objects:

1. To determine the labor, power* and machinery expenditures with different kinds of equipment for each field operation involved in the production of corn.
2. To obtain performance data that will:
 - a. Indicate the kinds of machinery and power best adapted to the field operations involved in producing corn.
 - b. Aid in the design and improvement of machinery for growing and harvesting corn.
3. To test the economy and effectiveness of different combinations of field operations, that is, different methods of growing corn. This may involve designing and building experimental machines when it is desired to try a new method or to do work on the soil or the crop for which existing machines are not suitable.
4. The ultimate objective is to lower the cost of producing corn by learning the most economical and advantageous applications of labor, power and machinery in corn production. These three items (labor, power and machinery) are under the farmer's control and, in Iowa, they ordinarily constitute from 55 to 65 per cent of the total cost of producing corn. It follows that these three items offer a promising field for study looking to reduction in operating costs.

* Wherever the word "power" is used without further definition in this project statement, it is to be understood to include power derived from either or both animal or mechanical sources.

PROCEDURE: The following outline indicates the different field operations involved in the production of corn and the machinery to be tested for each operation.

I. Disposal of the Residue of the Previous Crop

1. Cornstalks
 - a. Stalk cutter
 - b. Disk harrow
 - c. Machinery for cutting, raking, baling, burning.
2. Cover crops
 - a. Disk harrow

II. Seed Bed Preparation (Including all tillage operations up to time of planting.)

1. Work before plowing
 - a. Disk harrow
2. Plowing or principal operation of seed bed preparation
 - a. Moldboard-plow
 - b. Pulverator
3. Work after plowing up to time of planting
 - a. Disk harrow
 - b. Spring tooth field cultivator
 - c. Spike tooth harrow

III. Planting

1. Surface Planting
 - a. Check planting 42" x 42"
 - b. Check planting 30" x 30"
 - c. Check planting 21" x 21"
 - d. Drill planting 42" x 14"
 - e. Use of furrow openers and disk coverers
(Effect on weed control and crop growth)
2. Listing
 - a. Standard lister-planter
 - b. Basin lister-planter

IV. Cultivation of the Growing Crop

1. Early cultivation of surface planted corn; test machines at different speeds and adjustments; observe weed destruction and crop damage.
 - a. Spike tooth harrow
 - b. Spring tooth weeder
 - c. Rotary hoe
 - d. Cultivator with rotary weeder, spring tooth weeder and disk hillor attachments.

2. Later cultivation of surface planted corn
 - a. Two-row and four-row cultivators
 - b. Different shovel and disk equipment on cultivators
 - c. Power take-off driven cultivator (possible development)
3. Cultivation of listed corn
 - a. Spike tooth harrow
 - b. Disk harrow
 - c. Rotary hoe attachment to disk harrow
 - d. Listed corn cultivator
 - e. Shovel cultivator with disk hillers

V. Harvesting

1. Corn picker-huskers
 - a. Field tests to determine the effects of the following factors on field losses and on cleanness of husking using a standard make of corn picker:
 1. Date
 2. Time of day
 3. Air humidity and temperature
 4. Moisture content of ear, husk, shank
 5. Speed of operation
 6. Drilled compared to checked corn
 7. Corn varieties (cooperation with Field Crops Section of the Iowa Agricultural Experiment Station)
 - b. Field tests to compare the performance of different pickers under the same conditions.
 - c. Development of improvements in corn pickers to eliminate excessive field losses.
2. It is proposed to make a survey of other methods of harvesting corn.

TESTS TO BE MADE: Tests of each of the machines listed above will be made to determine labor, power, and machinery costs of its use and also to study its effectiveness in performing the desired operation.

Yield and weed control tests will also be made of different combinations of field operations performed with different kinds of machines. This can be done by dividing a field into strips for different methods of seed bed preparation, then cross dividing the field for different methods and machines for planting and cultivating. In this way a large number of comparisons can be made on one field and the work will be done under approximately farm conditions.

An additional test will be to select one or more of the most promising combinations of machines, that is, methods of growing the crop, and grow a field by each of these selected methods in order to get a more dependable record of the labor, power, and machinery costs in relation to crop yields and effectiveness of control of weeds, insects, and plant diseases.

The tests outlined above are to be made on an experimental farm near Ames, Iowa.

In addition to the work at Ames, it is proposed to secure some records in cooperation with farmers in different parts of Iowa. Information can be secured in this way regarding labor, power, and machinery expenditures with the use of methods, machinery or power units (such as hand husking of corn, use of one-row cultivators and of multiple-hitches) which we may not find it practical to use on the farm near Ames. Information can also be secured regarding the experience of practical farmers with the most efficient methods which they may have devised or which we may have suggested.

The outline of this project covers a wide variety of operations and treatments in preparation, seeding, cultivating, and harvesting. Each of the operations must be carried out in sequence for comparison with the others. At the end of the year complete records will be available for one year's operations but in order that any recommendations may be based on these investigations it is necessary to repeat the complete series of experiments for several years.

COOPERATION: Formal with Iowa Agricultural Experiment Station; informal with machinery manufacturers and Iowa farmers.

LOCATION: Ames, Iowa and selected farms in Iowa.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, 1935, \$10,000
Cooperators \$ 3,400

HISTORY: Professor J. B. Davidson has stated that "No factor in corn production, barring that of yield as influenced by climate and weather, varies so much as efficiency in the use of labor. In 1923 an examination of the records of the Bureau of Agricultural Economics, U. S. Department of Agriculture, revealed the fact that farmers themselves reported an expenditure of from three to three hundred hours of man labor in growing an acre of corn. Power is one of the largest items in the cost of production, varying from 20 to 40 per cent of the total cost under normal conditions. These are the principal items of cost under the control of the corn grower."

Some studies on this subject were initiated by the Iowa Agricultural Experiment Station in 1927. A field of 104 acres of corn tended with a general purpose tractor with three-row planting and cultivating equipment required 3.83 man-hours of labor per acre up to harvest.

In 1928 and 1929, using different kinds of tractors and equipment on a farm near Ames, Iowa which was foul with weed seed at the beginning of the period, the average labor requirement up to harvest was 6.32 man-hours per acre the first year and 4.96 man-hours per acre the second year. Harvest labor averaged 2.98 man-hours per acre when a two-row picker-husker was used and 4.09 man-hours per acre with a one-row machine. A report of these two years' work was prepared by Professor E. M. Mervine and is available in mimeographed form. Costs are shown for each operation as well as total costs of producing the crops.

The usual labor expenditure in growing corn on Iowa farms is from 6 to 12 man-hours per acre up to harvest. Some farmers have reported labor expenditures as low as four man-hours per acre up to harvest on surface planted corn. One farmer reported only 1.9 man-hours per acre on listed corn. In Nebraska, farmers have reported labor expenditures in growing corn as low as 2.7 man-hours per acre for surface planted corn and 1.1 man-hours per acre for listed corn. These low labor records in Nebraska were made under soil and climate conditions quite favorable for control of weeds.

Some studies of the use of two-row, three-row, and four-row tractor equipment in growing corn have been made at the University of Illinois, at Purdue University, at the Ohio State University, and at Pennsylvania State College. These studies have been informally reported upon from time to time at meetings of the American Society of Agricultural Engineers. Typewritten and mimeographed reports have also been prepared covering some of these studies. It is indicated that a very marked reduction in labor requirements is possible by use of multiple row equipment now available.

The use of tractors and multiple-row planters and cultivators opens up a new field in regard to possible closer spacing of corn. Experiments on this project during the past two years indicate that corn can be check planted 21" x 21", one stalk per hill, and cultivated with little if any additional labor or power expenditure as compared to ordinary 42" check planted corn. There are some experiments indicating a yield advantage for the narrower spacing. It seems probable also that corn in the narrow spacing will shade the ground so as to control weed growth earlier in the summer and therefore that the corn can be "laid by" earlier with consequent saving in expense of cultivating.

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The basin lister is a new implement invented and tried out on this project in 1933. This implement gives promise of being an important improvement over methods now in use. It will be given more extensive tests in 1934.

DATE EFFECTIVE: July 1, 1934

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 25

APPROPRIATION SYMBOL: 1091

PROGRESS REPORT REQUIRED: Semi-annually

TITLE: Forage Crop Drying

LEADERS: R. B. Gray, W. M. Hurst, E. D. Gordon.

OBJECTS: 1. To determine the power, labor, and fuel requirement of typical hay driers now in use.

2. To determine, through the use of commercial and experimental driers, the fundamental and physical factors involved in the artificial drying of forage crops.

3. To determine the effect of artificial drying on the quality and condition of the product by feeding experiments. (By the cooperators.)

4. To determine such factors involved in the selection and rotation of forage crops, the time of harvesting, and method of preparing the material for drying as affecting the economical application of artificial drying. (By the cooperators.)

PROCEDURE: The work on the project was started in July, 1930, when a conveyor type drier was installed at Jeanerette, Louisiana. Since that time experimental units embodying the rotary, heated crushing rolls, and tower drill principles have been constructed. Critical studies of factors involved in artificial drying, including the following, are to be continued:

1. Forage crops will be harvested and prepared for drying by either crushing, chopping, or whole and the cost of processing and quality of the product obtained from each of the four types of driers compared.

2. Studies will be made to determine and evaluate the following factors involved in rate and cost of drying:

- a. Maturity and fiber content of forage.
- b. Fineness of forage particles.
- c. Field wilting.

3. Field observations will be made wherever possible on privately owned installations.
4. Further attempts will be made to simplify the drying equipment so that the range of application of artificial drying of forage may be broadened to the average farm use.

Note. Heretofore considerable time has been devoted to routine drying. Now, with a slightly different set-up and the completion of the tower drier, practically the whole of Mr. Gordon's time will be devoted to research. This should enable him to soon determine if artificial drying is feasible, and if not, and its limitations.

COOPERATION: Bureau of Plant Industry, Bureau of Animal Industry, Bureau of Dairy Industry and Bureau of Agricultural Engineering. Informal, various planters owning driers.

LOCATION: Washington, D. C., Jeanerette, Louisiana, and field studies in other locations.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$7,000.00
Cooperators, \$2,000.00

HISTORY: In humid sections of the country unfavorable weather conditions at the time of making hay results in improper curing and, in some instances, a total loss of the crop. Under any set of conditions where the hay grower depends upon the natural drying of hay in the field, a large percentage of leaves - which are the most nutritious part of the plant - are lost by shattering in handling. Inferior or bleached hay is also caused by exposure to sun and rain.

The cost of drying forage artificially is excessive due in part to the high initial and operating cost of present drying equipment. The bulky nature of the forage, the large volume of water to be separated, and the uneven distribution of moisture in the forage when brought to the drier also aggravate the condition.

Observations have been made of typical commercial and experimental hay driers. A conveyor type has been built and operated at Jeanerette the past two years by Mr. Gordon. A drum drier, wherein use is made of undiluted furnace gases at high temperatures (1000° - 1600° F.) has been installed and operated the past year. These two types can be operated separately and in combination. Utilizing the exhaust gases from the drier to preheat the green

forage, wilting the hay in the field, or crushing it before drying reduces the drying cost. The tower drill recently constructed is simple, inexpensive, and has few high speed moving parts. If the performance of this drier is satisfactory a definite contribution will have been made in reducing the cost of drying forage artificially.

DATE EFFECTIVE: July 1, 1934

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering
BUREAU PROJECT NO.: 26
APPROPRIATION SYMBOL: 3201
PROGRESS REPORTS REQUIRED: January.
TITLE: Duty of Water.
LEADERS: W. W. McLaughlin and others of the Bureau.

OBJECTS: To obtain reliable data pertaining to the water requirements of plants and the irrigation needs of cropped lands; and the evaporation and seepage losses of irrigation water.

(1) To determine the total amount of water required in growing various crops, of the best quality and in suitable quantity; the seasonal and intervalic water requirement; and amount of irrigation water to apply and the method of its application for

- (a) Pears, citrus fruit, berries and walnuts;
- (b) Field crops, including small grains, alfalfa, corn, sugar beets, potatoes, rice, cotton, celery, and asparagus;
- (c) Native vegetation, including weeds, willows, brush, grasses, and tules and various other water-loving plants.

(2) To determine evaporation losses

- (a) From canals and ditches;
- (b) From water containing definite percentages of sodium chloride or other salts in solution, and the waters used in irrigation.

PROCEDURE: This is the major project of the Division of Irrigation and a considerable part of the work includes plans covering a set-up of from three to five years. Other of the work is incidental or emergency studies lasting usually about one or, at the most, two years.

Irrigation of Pears

The irrigation of pears at Medford, Oregon, will be in the third year of the five-year program. The plans of the work have not been changed since its inauguration except for incidental features. During the fiscal year 1934 a drainage system was installed to relieve a swale of excess water resulting from winter

rains. A new irrigation pipe line was also installed. A manuscript was prepared entitled "Studies of the Irrigation of Pear Orchards on Heavy Soils Near Medford". A progress report covering the season of 1933 is practically completed. This gives results of this work up to date. Several articles have been prepared for local presentation and for publication in various journals.

Irrigation of Citrus

The irrigation of citrus studies in the Pomona Valley of California are in the third of a five-year program. This work is being carried on in accordance with plans already approved. A progress report entitled "The Response of Lemon Trees to Different Irrigation Treatments" has been completed covering the work up to January 1, 1934. A second report "Irrigation in Alternate Furrows" has been prepared and material released to papers for publication.

The irrigation of citrus in the Salt River Valley, Arizona, since July 1933 to February 1934 was carried on almost entirely at the expense of the University of Arizona. Since February the work is back on the former cooperative basis. The plans previously approved for this work have been continued and a progress report completed covering the work up to July 1, 1933. The work for the fiscal year 1935 will be similar to that of the past year except that two orchards will be discontinued and two new ones taken up. The two discontinued were not suited to the work. The investigations to date indicate that the chloridic condition of the citrus trees is due to over-irrigation coupled possibly with alkali troubles. Investigations in the new orchards will determine irrigation requirements of citrus fruits.

The citrus work in the San Fernando Valley has been discontinued except for the completion of the progress report for publication. This is a cooperative study with the City of Los Angeles, and the working up of certain data by them from their own records is hoped to be completed during the fiscal year 1935 and a report prepared for publication.

In connection with the citrus studies at Pomona, we have developed a new furrower which is essentially a modified shovel-nosed cultivator. This tool has given excellent satisfaction and through its use we are able to get better penetration of irrigation water.

Irrigation of Cotton

On July 1, 1933 we were compelled to withdraw much of our financial support to this project and it has since been carried on by the University of California until March 15, when the Bureau

again became actively engaged in the project. For the season 1934 we will be in the third year of what was to have been a three-year program but financial conditions changed the program until we are now in the second year of the three-year program, the object of which is to determine the best field method for the irrigation of cotton grown on heavy soils. Quarterly and annual progress reports have been prepared. During the past year we have demonstrated on several farms that the first irrigation can be omitted without lessening but frequently increasing the yield, thereby saving expense in growing. This practice seems to offer much in the way of economy in production. Expenditures for the fiscal year 1935 will probably not exceed \$1,000 by this Bureau.

Irrigation of Asparagus and Other Vegetables in the Sacramento-San Joaquin Delta:

This work has been continued as previously approved and it is expected that final report will be completed during the winter of 1934-35, thus closing out the crops now under investigation. Progress reports are prepared annually and published by the California State Department of Public Works in regular annual report form.

Irrigation of Field Crops in cooperation with the Bureau of Plant Industry at Mitchell, Nebraska, and Bard, California:

These studies are in the third year of a five-year program. An annual report has been prepared covering the work at Mitchell, Nebraska, during the season ending January 1, 1934. A similar report is about completed for the work at Bard, California.

Incidental Irrigation Studies:

Many incidental studies are carried on with very little additional expense, such for instance, as the irrigation of berries in the Willamette Valley, Oregon. The season of 1934 will be the second year of this study.

Water Requirements of Non-Crop Plants:

Studies in the coastal region of California were completed last fiscal year and the results published as a part of Bulletin 44, California Department of Public Works. This same publication contained results of water requirement of stream-bed vegetation in southern California, which will be continued during the coming season. The results in general show that weeds use, as a rule, much more water than crop plants and that a weed-infested crop requires much more water than one where weeds are absent.

Investigations at Kootenai, Idaho:

Three seasons' work has been completed which has for its objective the determination of the effect of the proximity of the ground water to the surface upon crop production. Progress reports have been completed annually and the one for the 1934 season is about completed. This is a cooperative study and is financed by the Department of Justice. The work will be continued for the growing season 1934.

Additional Work:

A preliminary report was prepared on the winter killing of alfalfa in the Northwest. This gives results of winter kill for the season 1932-33. It is proposed to inaugurate a study of the control of winter killing by irrigation, since the quantity of soil moisture is one of the principal factors in determining the extent of winter kill, when money is available.

An additional report was prepared entitled "Irrigation Requirements of Arid and Semi-Arid Lands of the Pacific Slope Basin". A mimeographed report was prepared abstracting Bulletins 8 and 36 of the California Department of Public Works and was entitled "Cost of Irrigation Water in California".

Rainfall penetration in its relation to irrigation in Ventura County, California, which is a two-year study, was completed, and the results in course of publication by the State Department of Public Works as a part of a bulletin dealing with water development in Ventura County.

In addition to the above reports and bulletins, several articles were prepared for publication giving specific results, resulting from work on project 3201.

It is proposed, for the fiscal year 1935, to continue, on approximately the same scale as heretofore, the pear investigations at Medford, Oregon; irrigation of strawberries in the Willamette Valley; preliminary work on irrigation studies at Hermiston, Oregon; irrigation of citrus in southern California and in Salt River Valley, Arizona; irrigation of cotton in central California; the water requirements of non-crop plants in southern and central California and Fort Collins, Colorado; and irrigation studies at Kootenai, Idaho.

COOPERATION: State Agricultural Experiment Stations, and other Federal, State, and private agencies.

LOCATION: Texas, California, Colorado, Idaho, Oregon, and Nebraska.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures for fiscal year 1935, by the Bureau of Agricultural Engineering, \$49,700. A smaller sum will be spent from State cooperative funds.

HISTORY: Duty of water investigations by this Division and its predecessors and cooperators have been carried on for 35 years or more, or ever since the creation of the Office of Irrigation Inquiry. There have been different epochs, as indicated by the method of procedure and the precision of the methods used.

Our investigations point to the conclusion that there is in general between a crop's consumptive use of water and its yield a degree of correlation that is serviceable in estimating or predicting the amount of water necessary in the irrigation of the crop; and that, in most instances observed, the correlation is not materially disturbed by variations in soil and soil conditions. On the other hand it has been determined, as a result of practice and by experimentation, that it is much easier to irrigate some soils than others, and that less water is required in getting over some fields than others of the same areas. In our soil moisture work also it has been found that we can account for more or less of the water applied in irrigation, depending upon the type of soil. All these factors led up to the investigation, as indicated by the OBJECT, that is, soil and plant requirements for water in irrigation. Many bulletins have been published by this Division and its predecessors on water requirements of crops, and the irrigation needs of the farmer.

In order to segregate evaporation and transpiration losses, experiments have been conducted in tanks, with the soil bare or planted to various crops, and the results have been compared. Likewise, there is a loss of water by direct evaporation from the water itself, and in order to determine this loss in various localities, we are now and have been conducting investigations of evaporation loss from free water surfaces, by the use of Weather Bureau type A pans. Results of this work have been published from time to time, the most recent publication being Technical Bulletin No. 271, "Evaporation From Free Water Surfaces".

There has been considerable discussion at various times of the effect of different concentrations of alkali in solution on the rate of evaporation. Some two or three years ago this Division undertook studies on the relative evaporation from free water surfaces in Weather Bureau type A pans with different concentrations of sodium chloride in solution. A progress report was published last year on this subject and the work in progress this year is only incidental and to fill out a few missing points in our evaporation curve.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

1. The first part of the paper is devoted to a discussion of the general principles of the theory of the structure of the atom.

2. The second part of the paper is devoted to a discussion of the general principles of the theory of the structure of the atom.

3. The third part of the paper is devoted to a discussion of the general principles of the theory of the structure of the atom.

4. The fourth part of the paper is devoted to a discussion of the general principles of the theory of the structure of the atom.

5. The fifth part of the paper is devoted to a discussion of the general principles of the theory of the structure of the atom.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 36

APPROPRIATION SYMBOL: 6000-2

PROGRESS REPORTS REQUIRED: Annually and to suit the exigencies of the project.

TITLE: Cotton Ginning Investigations.

LEADERS: Chas. A. Bennett; V. L. Stedronsky.

OBJECTS:

1. To discover fundamental laws governing cotton conditioning, cleaning, extracting and ginning, with the view to improving the quality of the ginned crop of cotton in the United States.
2. To determine the mechanical effects of mechanical devices and arrangements, their inter-relationships and their correlation with the elements of quality resulting in the samples of ginned lint and ginned cotton seed.
3. To develop dependable and optimum mechanical methods for producing ginned cotton of uniform high grade, superior "preparation", and better spinning qualities.
4. To develop standardized testing and ginning methods applicable both to these investigations and to existing commercial installations.
5. To develop, invent, and devise sundry research apparatus pertaining to the engineering and fiber analysis aspects of the problems.

PROCEDURE: Work during the fiscal year 1935 will comprise analysis of reports on investigations previously conducted; continuation of laboratory ginning tests upon a number of varieties of seed cotton from different States; continuation of laboratory research tests regarding mechanical construction and functions of gin saws, moting devices, airblast and brush doffing methods, and the like; and new studies in construction and function of new types of driers, cleaners and gins.

To be included in the investigations are field tests at representative public cotton gins to supplement gaps in cleaning and extracting tests with master units not available at the laboratory; and to make repeat tests which cover a cycle of years upon fixed varieties of seed cottons under established test conditions, with a view to ascertaining what periodic variations and peculiar characteristics, if any, may exist.

To be also included in the investigations are field tests on Government design vortical driers in northeast Arkansas, South Texas, the Mississippi Delta, and Alabama, with a view to obtaining operating costs and commercial benefits in these several regions.

The work of the fiscal year 1935 is expected to continue to bear upon the more complicated aspects regarding the internal construction of cotton gins, with emphasis upon photographic evidence of the operations and behavior of mechanical elements. Where possible, such features as doffing angles and nozzle jet divergence of the airblast, tooth penetration into seed roll and distribution of fibers along edge of tooth, breast and seed roll functions, comparability of roller and saw gin effects, and other features will be tested.

New and existing drying apparatus will be tested under a wide range of temperatures and exposures in the recently fire-proofed rooms of the laboratory; conditioning equipment will be installed and operated in the principal spaces of the ginning laboratory for reproducing different weather conditions during tests; and dry cottons will be adjusted to different moisture contents by means of this equipment with a view to more accurate measurement of the effects of moisture upon the quality and ginning efficiency of a given seed cotton.

Construction of testing instruments are to be especially expedited with reference to the development of suitable indicators for seed roll density, the need for which is recognized as being of major significance in obtaining accurate and optimum standardization of gin control by visual means rather than by dependence upon existing methods which employ the sense of feeling.

COOPERATION: The Bureau of Agricultural Economics; Mississippi Delta Experiment Station; and informal cooperation with cotton plantations and manufacturers of cotton handling machinery.

LOCATION: At Stoneville, Mississippi, and elsewhere in the cotton belt as may be necessary.

LEGAL AUTHORITY: An act (H.R.10173) which authorized the Secretary of Agriculture to conduct investigations of cotton ginning, and Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$32,000.

HISTORY: Important findings have been made concerning the value of artificial drying of seed cotton immediately prior to ginning; and substantial indications concerning the action of seed rolls, saw speeds, accessory speeds, etc., have been obtained.

DATE EFFECTIVE: July 1, 1934.

APPROVED:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 37

APPROPRIATION SYMBOL: 2133

TITLE: Irrigation in the Humid Section

LEADERS: Lewis A. Jones, F. E. Stachner

OBJECTS: Develop more economical equipment and methods of irrigation in the humid region.

PROCEDURE: During the fiscal year 1935:

- A. Investigations will be continued to determine efficiency and limitations of portable spray equipment and surface irrigation equipment in the irrigation of various crops. Portable wheeled spray lines will be constructed and tested to determine their efficiency, as well as the length of line it is feasible for two men to move. In connection with surface irrigation, an attempt will be made to develop low cost types of diversion boxes and outlets or hydrants, and tests will be made to determine the safe heads under which various sizes of vitrified sewer pipe may be operated.
- B. A comparative study of the cost and efficiency of the following methods of irrigation will be started.
 1. Iron pipe system, surface.
 2. Ooze hose.
 3. Wheeled portable spray.
 4. Sewer pipe system, surface.
- C. Investigations will be made to determine the effect of different frequencies of irrigation, and of different quantities of water applied per irrigation, on strawberries and raspberries. Different varieties of berries will be irrigated and the effect on yield, length of fruiting season, grade of berries, etc., will be noted.
- D. The effect of the time of irrigation upon yield, fruit bud formation, etc., will be noted, and the effect of irrigation upon cultural practices, such as topping strawberries, will be investigated.
- E. Experiments will be conducted with a view of developing equipment that will indicate in a practical manner when the soil on an irrigated tract is in need of water.

F. Iso-irrigation need maps will be developed for several states based upon recorded rainfall data, general soil characteristics and principal crops.

COOPERATION: Bureau of Plant Industry

LOCATION: Beltsville, Maryland, and Willard, North Carolina.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURE: Bureau of Agricultural Engineering, \$5,000.

HISTORY: In 1909, and in several subsequent years, representatives of the Department of Agriculture carried on engineering investigations concerning irrigation in the humid region. The work was started in Florida. As a result of this work the relatively cheap method of delivering water by means of lines of sewer pipe to suitable places in areas of flat or favorably sloping topography was developed. Since that date a number of citrus orchards in Florida covering a large acreage have been equipped with this type of irrigation.

Subsequently considerable work was done in New Jersey. The farming here was more intensive and the interest more easily centered on the expensive spray irrigation. In the areas devoted to the growing of valuable truck crops a large and steadily increasing amount of high-priced spray irrigation equipment has been installed. Further work looking to the installation of effective irrigation of a cheaper variety led to the installation of some surface irrigation equipment for the less profitable crops. The interest in this has continued and further installations of surface irrigation have been made even during the financial emergency of the last two years.

The results obtained have been published in the following bulletins of the Department of Agriculture:

Department Bulletin 495, Spray Irrigation, 1917
Department Bulletin 462, Irrigation in Florida, 1917
Farmers' Bulletin 899, Surface Irrigation for Eastern Farms, 1917
Farmers' Bulletin 899, Surface Irrigation for Eastern Farms (Revised), 1924
Farmers' Bulletin 1529, Spray Irrigation in the Eastern States, 1927
Farmers' Bulletin 1635, Surface Irrigation in the Eastern States, 1930
Circular 195, Tests of Spray Irrigation Equipment, 1931

Results of early investigations were published in the following bulletins issued by the Department:

Farmers' Bulletin 46, Irrigation in Humid Climates, 1896
O. E. S. Bulletin 36, Notes on Irrigation in Connecticut
and New Jersey, 1897
O. E. S. Bulletin 87, Irrigation in New Jersey, 1900

DATE EFFECTIVE: July 1, 1934

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 17

APPROPRIATION SYMBOL: 5404

PROGRESS REPORTS REQUIRED: Annually in July.

TITLE: Relation of Storage House Construction
and Management to Storage Losses of White
Potatoes.

LEADER: A. D. Edgar.

OBJECTS: To develop practical methods for reducing losses of white potatoes in storage, and for increasing the useful life of storage buildings; to develop new types of structures and equipment for handling potatoes.

Objectives for the fiscal year 1935 include an investigation of improved type of construction for storage house walls, studies of potato storage in crates, in cooperation with the Maine Experiment Station, and preparation of publications based on work done during the past three years.

PROCEDURE: The Maine Experiment Station has invited the Bureau to cooperate in the study of storage of potatoes in crates using the potato warehouse on the State Experiment Farm at Presque Isle. The work will include the study of shrinkage losses in crates as compared to bin storage, methods and comparative costs of handling, and suitable design of houses for this purpose. Work will also include studies in cooperation with farmers who have built or contemplated the building of improved potato storage houses.

It is expected that considerable time will be spent on the publication of a bulletin giving the results of this work and that of previous years.

COOPERATION: Bureau of Plant Industry; Maine Agricultural Experiment Station; informal cooperation with storage house owners, Presque Isle, Maine.

LOCATION: Presque Isle, Maine.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$4,500.

HISTORY: The need for improved potato storage houses has been recognized for years in potato growing sections. Many plans for improvement have been suggested by State experiment stations and other agencies. The Division of Agricultural Engineering in

cooperation with the Bureau of Plant Industry carried on studies at Presque Isle, Maine, from 1924 to 1927. These studies resulted in an improved type of trackside storage house which is replacing the older types of trackside houses. During the past three years further studies were carried on at Presque Isle, Maine, to apply laboratory findings of the Bureau of Plant Industry to commercial storage conditions and to secure further information about the requirements for construction, arrangement, and ventilation of potato storage houses.

Work during the winter of 1933-34 was carried on in the storage house of the Maine Experiment Station at Presque Isle, Maine.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering
BUREAU PROJECT NO.: 16
APPROPRIATION SYMBOL: 5403
PROGRESS REPORTS REQUIRED: January and July
TITLE: Storage and Transportation of Fruits
and Vegetables.
LEADERS: Wallace Ashby, W. V. Hukill and S. J. Dennis.

OBJECTS: To determine the fundamental conditions required by perishable plants, fruits and vegetables for their safe storage and transportation, particularly over long distances, and their delivery at destination in sound marketable condition, and to devise and test means and methods for the accomplishment of these ends.

Objectives for the fiscal year 1935 are to measure the rate of heat production and the specific heat of various fruits and vegetables; to develop and test apparatus for more accurate measurements of temperature and air movement in connection with shipment or storage of fruits and vegetables; and to complete, if possible, studies on the effect of color on the surface temperatures and heat absorption of insulated walls exposed to sunlight.

PROCEDURE: Calorimeter studies of the heat given off by various fruits and vegetables under typical storage conditions will be made with the new calorimeter developed during the past year. Surface temperature studies, and development and test of low velocity anemometers will be carried on at Arlington Experiment Farm, Virginia.

It is hoped that one or more transit tests with shipments of fruits and vegetables in refrigerator, ventilator, or heater cars, or other means of transportation, with inspection of shipments at destination, may be made to further determine the conditions required for the safe transportation and various products and the relation of transit conditions to the condition of the products on arrival at market and their behavior during the marketing period.

COOPERATION: Bureau of Plant Industry; informal cooperation with shippers and receivers of fruits and vegetables; transportation companies, Agricultural Colleges, State Departments of Agriculture, and the Geophysical Laboratory of the Carnegie Institute.

LOCATION: The work will be carried on at Arlington Experiment Farm, Virginia, at fruit production centers of the country, in transit from those centers to marketing places and in the marketing centers.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$4,500.

HISTORY: This work was started many years ago. In 1921 the engineering part of the work was transferred to the Division of Agricultural Engineering, Bureau of Public Roads, and is now in the Bureau of Agricultural Engineering. The work in the past has covered precooling and refrigeration plants, for fruits and vegetables, storage houses, and refrigerator cars. Recent work includes determination of temperature in structural parts of cars in relation to the amount of heat passing into and out of the car, the effect of color of outer walls and roof on the heat absorbed by car, and tests of warming devices and means of heating cars used in the shipment of perishable products in cold weather. A very delicate calorimeter for determining the amount of heat given off by fruits and vegetables in storage has been built and calibrated and will be used during the coming year.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 14

APPROPRIATION SYMBOL: 5401

PROGRESS REPORTS REQUIRED: January and July

TITLE: Grain Storage

LEADERS: M. A. R. Kelley and J. R. McCalmont.

OBJECT: To study present farm corn storages, separate and combined with storages for small grain, and equipment for grain handling in corn growing states, with a view to the development of recommendations for improvement in the construction of storages and methods of handling.

PROCEDURE: The work contemplated for 1935 includes a cooperative study with the Department of Agricultural Engineering, Ohio State University, of the structural design and ventilation of corn cribs.

COOPERATION: Ohio Agricultural Experiment Station.

LOCATION: Columbus, Ohio.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$1,000.

HISTORY: The storage of "soft corn" is a particularly important problem since large losses result from the improper storage of such grain. It is anticipated that recommendations which are being made by certain agricultural colleges regarding late planting of corn as a means of controlling the European corn borer may materially increase the amount of "soft corn" that farmers in these states will have to handle in the future. There have been many structural failures of corn storages owing to improper construction, particularly the lack of adequate braces and ties. A field study of corn and small grain storage on corn belt farms was made in 1930 and 1931.

Pressures on walls, floor, and cross-braces of an experimental corn crib were measured during the winters of 1931-32 and 1932-33. A report of this work was made at the December 1933 meeting of the American Society of Agricultural Engineers and will be published in the Journal of Agricultural Engineering. The experimental corn crib used for the tests has now been moved from Toledo, Ohio, to Columbus, Ohio, due to abandonment of the Corn Borer Experiment Farm at Toledo.

DATE EFFECTIVE: July 1, 1934

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 10

APPROPRIATION SYMBOL: 5201

PROGRESS REPORTS REQUIRED: January and July

TITLE: Improvement of Farm Buildings
Sub-Project - Improvement of the Farmhouse.

LEADER: Wallace Ashby.

OBJECTS: To determine the most economical and effective procedure for the improvement of present and future farmhouses. The development of materials, methods, and plans for low-cost farm homes will be given special attention.

There are two objectives for the fiscal year 1935. The first is to make a careful study of the data secured in the recent survey of approximately 500,000 farmhouses. This study should be especially valuable in directing future work on farmhouse design and remodeling. Second, to organize the large amount of material on farmhouse remodeling which has been sent in by engineers in the various counties and the material collected and partly worked up by architects and engineers at the various state colleges.

PROCEDURE: Survey summary sheets are now coming in from State workers. These contain an immense amount of valuable information about farmhouse conditions and farmers' housing needs. This information should be carefully classified, tabulated, and perhaps shown in graphic form on maps. It will be helpful to technical workers in agriculture and also of much interest to manufacturers of building materials and equipment used in farmhouses.

The material on farmhouse remodeling includes a large number of sketches, cost records and photographs showing work actually done by farmers in the improvement of their houses. Specifications have also been prepared for farm heating and lighting plants, farm plumbing, electric wiring, and built-in equipment. In view of the probability that methods of government financing will probably be made available for the repair and remodeling of farm as well as urban houses, this information should be made available in the form of bulletins as soon as possible.

COOPERATION: Informal cooperation with the Bureau of Home Economics and the Agricultural Experiment Stations of 18 States.

LOCATION: Washington, D. C.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$15,000.

HISTORY: Work on improvement of the farmhouse was begun in the Office of Farm Management in 1914 and was transferred to the Division of Agricultural Engineering, Bureau of Public Roads the next year. During the war years and the ensuing depression in agriculture, little attention was paid to this work. Interest was revived by the President's Conference on Home Building and Home Ownership in 1931 which studied and made available much material bearing on the problems to be solved. During the fiscal year 1933, brief surveys of farm housing conditions were made in Ohio, Michigan, North and South Carolina, Georgia, and Alabama, and observations of a few houses were made in Mississippi, Tennessee, Kentucky, Massachusetts, and Maine.

In December, 1933, a survey of 500,000 farmhouses in 300 representative counties throughout the United States was undertaken as a Civil Works Project to be carried on cooperatively by the Bureau of Home Economics, the Bureau of Agricultural Engineering, the Extension Service and the Office of the Secretary. Field work on this survey was completed in March 1934. Some 4700 people took part in this survey which was completed in March 1934. In addition to workers on the survey some 50 architects and draftsmen were employed at 18 State Colleges and in Washington preparing about 100 plans for farmhouses. Approximately 40 of these plans have been selected for publication as a Farmers' Bulletin on farmhouses.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 9

APPROPRIATION SYMBOL: 5101

PROGRESS REPORTS REQUIRED: Final reports now being prepared.

TITLE: Study of the Relation of Stable Air
Conditions to Milk Production.

LEADER: M. A. R. Kelley.

OBJECTS: To determine the optimum stable air conditions for milk production by dairy cows, the effect of sudden changes in stable temperature on milk production and types of construction needed to provide satisfactory stable conditions.

PROCEDURE: Work during the fiscal year 1935 will be confined to compilation of field data previously obtained and the preparation of reports and publications. The analyses of the field data consisting of more than 20,000 milk records and a large number of butterfat, stable temperature humidity and other records will be completed. Factors will be correlated to determine optimum air conditions and effects of sudden temperature changes in milk yield, butterfat yield and health of cows. Effects of ventilation, heat losses through the walls, and similar factors, on milk production and health of animals will be studied.

COOPERATION: The Bureau of Dairy Industry; the Agricultural Experiment Station of the University of Wisconsin; Brook Hill Farm, Inc., Genesee Depot, Wisconsin.

LOCATION: Washington, D. C.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$1,000.

HISTORY: The field studies were carried on at Brook Hill Farm, Genesee Depot, Wisconsin. During the winters of 1930-31 and 1931-32, records of stable conditions and milk production were kept for 88 cows in a single barn, divided into four equal stables. During the winter of 1931-32, eight cows in addition to the above were studied in an open barn.

The studies in these experimental stables were supplemented by a survey of milk yields and barn conditions on 63 dairy farms in the vicinity of Genesee Depot to find the effect of sudden

temperature change on milk yield in barns of different construction and exposure during the cold period of March 1932. Similar data was secured for part of these barns for the winter of 1932-33. The study has been further extended by comparative records secured in two farm barns at Presque Isle, Maine, during the winter of 1933-34.

It now remains to complete the analyses of these data obtained in the above tests and prepare this report for publication.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 8

APPROPRIATION SYMBOL: 2501 to 2512

PROGRESS REPORTS REQUIRED: January.

TITLE: Control of Soil Erosion.

LEADERS: Lewis A. Jones, C. E. Ramser.

OBJECTS: The objects of this investigation are to determine the carrying capacity of terraces for the prevention of soil erosion and the conservation of water on agricultural lands; to develop economical methods of constructing terraces that will permit the land to be farmed with modern farm machinery; and to develop satisfactory methods of constructing soil-saving dams with various kinds of material. The required capacity of terraces depends upon the slope of the land, the spacing and grade of the terraces, the character of the soil, the character of the crop, and the amount and distribution of the rainfall. Properly designed and constructed terraces tend to hold a large part of the rainfall on the land, thus increasing the amount of moisture available for plant growth. This investigation will include a study of all of these factors with reference to the more erosive soil types classified by the Bureau of Chemistry and Soils. An attempt will be made to develop equipment that will reduce the amount of labor required to construct terraces; and to develop greater flexibility in existing farm machinery so as to improve the operation of such machinery over terraced land.

PROCEDURE: Ten soil erosion experiment farms of from 150 to 300 acres have been established under widely different climatic conditions, on various types of soil where erosion and moisture control are serious problems. Terrace systems of various types with different spacings and slopes have been constructed. Soil-saving dams of various types are being experimented with. Rainfall is being measured; run-off measurements are being made from both terraced and unterraced watersheds under various conditions of slope and cover. Soil analyses are being made to determine the physical characteristics of the soil. The rate of erosion on terraced and unterraced land is being determined and the effect of terrace systems on the conservation of water falling on the land will be noted.

The land is being cultivated with modern farm machinery with a view to determining and overcoming difficulties that arise in cultivating terraced land with such equipment. The requirements for machines to economically construct terraces are being determined.

The investigations will have to be carried on over a period of several years before sufficient data has been obtained to warrant making definite conclusions upon the best design for terraces and soil-saving dams under various soil and climatic conditions.

COOPERATION: The investigations will be carried on in cooperation with the Bureau of Chemistry and Soils, the Forest Service, state experiment stations in the states where the experiment farms are located, and various other state and local organizations interested in the control of soil erosion and moisture conservation.

LOCATION: Guthrie, Oklahoma; Temple, Texas; Tyler, Texas; Hays, Kansas; Statesville, North Carolina; Raleigh, North Carolina; Pullman, Washington; La Crosse, Wisconsin; Zanesville, Ohio; Bethany, Missouri.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935, U. S. Department of Agriculture, Soil Erosion Investigations, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures, fiscal year 1935:

Bureau of Agricultural Engineering	
Agricultural Engineering Appropriation	\$ 6,000
Soil Erosion Appropriation	81,937
Bureau of Chemistry and Soils	81,937
Other cooperating agencies	15,000

HISTORY: The study of terracing and other methods of controlling soil erosion was begun by the Bureau of Agricultural Engineering in 1915. The results have been published in Department Bulletin 512, "Prevention of Erosion of Farm Lands" (1917); Farmers' Bulletin 1234, "Gullies, How to Control and Reclaim Them" (1928); Farmers' Bulletin 1386, "Terracing Farm Lands" (1928); and Farmers' Bulletin 1669, "Farm Terracing" (1931). Three progress reports have been issued on the North Carolina work. State Extension Services of fifteen states have issued bulletins relating to terracing, based largely upon the Bureau publications listed above. During 1929 soil erosion experimental farms were located near Guthrie, Oklahoma; Temple, Texas; and Hays, Kansas. Additional experiment farms were located near Statesville, North Carolina; Bethany, Missouri; Tyler, Texas; and Pullman, Washington, during 1930; near Clarinda, Iowa, during 1931 and La Crosse, Wisconsin, during 1932. The last station was established near Zanesville, Ohio, in the fall of 1932.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 6

APPROPRIATION SYMBOL: 2138

TITLE: Groundwater Studies in the Peat and Muck Soils of Florida.

LEADERS: Lewis A. Jones, B. S. Clayton.

OBJECT: The ultimate object of this investigation is to determine the effect of controlling groundwater elevation upon the productivity of the peat and muck soils of Florida. The elevation of the groundwater depends upon the character and amount of rainfall, the depth and type of drainage, the rates of subsidence of the drained soils, the rates of percolation through the soils under various conditions of drainage, and the rates of evaporation and transpiration. This investigation will accordingly include a study of all of these factors affecting groundwater conditions.

PROCEDURE: The installation of the groundwater control plots, lines of observation wells, and evaporation tanks has been completed. During the fiscal year 1935 the work will be limited largely to the operation of the pumping plants, observation of groundwater fluctuations and recording of crop growths and yields on drained and undrained land. Records on the project will have to be obtained for several years to offset variations in climatic conditions from season to season.

COOPERATION: Formal cooperation with the Agricultural Experiment Station of the University of Florida. Informal cooperation with drainage districts and individual farmers.

LOCATION: Everglades Experiment Station, Belle Glade, Florida.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, fiscal year 1935.

PROPOSED EXPENDITURES: Anticipated expenditures for fiscal year 1935, Bureau of Agricultural Engineering, \$4,000; Everglades Experiment Station, \$2,200.

HISTORY: Some investigations relating to the drainage of peat soils have been made in Minnesota, Wisconsin, and Oregon, and certain of the European experiment stations have conducted investigations relating to the effect of drainage upon peat and muck soils. However, the results secured in such investigations are not applicable to sub-tropical conditions. The Bureau of Agricultural Engineering has conducted some studies of the subsidence of drained peat

soils in Florida. No systematic investigations along the lines proposed have been attempted under the soil and climatic conditions existing in the Everglades of Florida. This project was established in March, 1931.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 23

APPROPRIATION SYMBOL: 1081

PROGRESS REPORTS REQUIRED: Semi-annually.

TITLE: Spraying and Dusting Equipment.

LEADERS: R. B. Gray and E. M. Dieffenbach.

OBJECTS: To ascertain what types of existing spraying equipment are best adapted to control the ravages of plant diseases and insect pests, and to develop such new equipment or appliances as may be necessary.

PROCEDURE: (a) Investigations during the fiscal year 1935 will be limited chiefly to spraying equipment for pecan trees.

(b) Studies will be made of the performance of various types of spray guns, with special reference to the amount of discharge, distance of drive, distribution of spray, and pressure loss. The maximum height to which it is possible to spray with existing equipment will be determined. A focal plane shutter arrangement was constructed the past year to facilitate studies of spray distribution.

(c) Observations will be made on the different types of spray hose available, and comparisons made in regard to weights, dimensions under pressure and empty, flexibility, and strength. Preliminary tests of friction losses in different types of hose have been made the past year.

(d) The quantity of liquid necessary to spray pecan trees of various sizes will be determined.

(e) Comparisons will be made of portable and stationary outfits as to effectiveness, performance, initial cost and cost of operation.

(f) Observations will be made of the corrosive and wear resistance of various metals and alloys when used with the various spray solutions. Preliminary studies of the corrosive action of typical spray solutions on various spray nozzle disc materials is under way.

(g) Alterations in existing equipment, the bringing in of equipment from other fields, or the design of new equipment which will tend to improve performance will be undertaken when conditions warrant. The design of a ball-valve spray gun cut-off has been completed.

(h) Available spraying outfits are to be used in testing various types and sizes of nozzles and accessories, and observations made on both Government-owned and privately-owned equipment. At the end of the year a report will be available covering the year's activities.

COOPERATION: Bureaus of Entomology and Plant Industry; informal with manufacturers of spraying machinery and interested growers.

LOCATION: U.S.D.A. Pecan Investigations Laboratory, Albany, Georgia, and in the orchards of interested growers.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$3,800
Cooperators, 1,200

HISTORY: Effective insecticides and fungicides have been developed by the Bureaus of Entomology and Plant Industry, respectively, for controlling certain insect pests and plant diseases. Little work, however, of a technical nature has been done on the development and refinement of mechanical methods of application such as would tend to effectively yet economically control these enemies of the pecan growers. This investigation was started in the fall of 1931.

The principal limiting factor of pecan production of the improved varieties in the southeastern part of the United States is a fungus disease called pecan scab. The only known protection against scab is spraying and dusting. Pecan scab is widely distributed throughout the Southeastern States, having been reported from North Carolina, South Carolina, Georgia, Florida, and Alabama, also from Mississippi, Louisiana, Arkansas and Texas.

The chief insects injuring the pecan which can be controlled by spraying are the pecan leaf case-bearer, and the pecan black aphid. The fall webworm and walnut caterpillar do damage in some seasons, and can also be controlled by the same method. The above insect pests are usually the most serious in the southern part of the pecan growing area.

Observations have been made as to the performance of stationary spray plants and field tests have been made on portable outfits. Method of procedure in spray gun manipulation appears to be about as important as nozzle characteristics. The former can easily be controlled but the latter is dependent on nozzle design. Spray patterns of nozzles have indicated that much can yet be done to improve "fogging" of the spray as well as to improve the uniformity of its distribution.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 4

APPROPRIATION SYMBOL: 2135

PROGRESS REPORTS REQUIRED: July and January

TITLE: Drainage of Sugar Cane Lands.

LEADERS: Lewis A. Jones, B. O. Childs.

OBJECTS: 1. To study the effectiveness of deep open ditches in the drainage of lands growing sugar cane, and the practicability of tile for draining such lands.

2. To determine the most advantageous depth and spacing of drains for sugar cane lands, and the effect of drainage upon yield of cane and sugar.

3. To determine the effect of deeper and more thorough soil drainage of these lands upon the amount of water that must be discharged by the drainage pumps.

4. To determine the practicability of pumping from wells in the drainage of sugar cane lands.

PROCEDURE: On a portion of the sugar plantation of the Houma Sugar Company, located near Houma, Louisiana, old drainage ditches have been deepened, new ditches of varying depth have been constructed and experimental tile drains of different depths have been constructed. Measurements are being made of the water discharged from the different drained tracts, and fluctuations of groundwater tables are being observed in relation to the depth and arrangement of the drains. Due to lack of depth in outlet ditches for the experimental tracts, all of the drainage water from the plots is collected in pumps and pumped. Observations of the growth of cane are being made for comparison with that on undrained or partly drained lands, and records of the yields will be obtained from the plantation owners. The construction work on the project was completed in June 1932. During the fiscal year 1935, the work will be limited to the operation of the pumping plants, run-off measurements, observation of groundwater fluctuations and recording of crop growths and yields on drained, partially drained, and undrained land.

One plot of land will be surface irrigated to determine the benefits to be derived from irrigation in growing cane in southern Louisiana.

Records on the project will have to be obtained for several years to effect variations in climatic conditions from season to season.

COOPERATION: Houma Sugar Company.

LOCATION: Southern Louisiana (Headquarters at Houma, Louisiana.)

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Fiscal year 1935, \$5,800.

HISTORY: Investigations relating to drainage in the coastal section of Louisiana and to the operation of drainage pumping plants in that State were made by engineers of the Department of Agriculture in 1911 to 1917. Engineering studies relating to irrigation of sugar cane in the same region were made by the Department in 1922 to 1926. The latter studies in particular made apparent the need for the investigations here outlined.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 2

APPROPRIATION SYMBOL: 2111

PROGRESS REPORTS REQUIRED: January and July.

TITLE: Flow Around Channel Bends.

LEADERS: Lewis A. Jones, D. L. Yarnell.

OBJECTS: To complete the report on the experiments already made on the flow of water around bends and to continue the experiments for the purpose of determining the following phases of flow around channel bends.

1. Measure the changes in velocity and pressure as water flows around curved channels.

2. To determine the laws governing the change in velocity and pressure for flow around bends.

Tests are needed primarily to amplify the results already secured on bends, and to determine the laws controlling the behavior of water as it flows around bends of different degrees of curvature.

PROCEDURE: The tentative schedule of operations as planned for the fiscal year 1935 is to continue laboratory tests with apparatus used during the fiscal year 1934, until tests of bends of the following types have been made: (1) A bend with both variable radius and variable shape of cross-section; (2) Three bends of circular cross-section, 6 inches in diameter and variable radii. Tests will be made for loss of head and uniformity of velocity distribution. If funds are available tests are also to be conducted on open channel bends of rectangular cross-section, the bed of the channel being of "erodible" material, in order to study the changes in section which take place.

COOPERATION: The State University of Iowa will furnish its research facilities, part time of its research assistants, and the consulting services of Professor Woodward.

LOCATION: Iowa Institute of Hydraulic Research, University of Iowa, Iowa City.

LEGAL AUTHORITY: Appropriation Act, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures for the fiscal year 1935, Bureau of Agricultural Engineering, \$6,500, Iowa Institute of Hydraulic Research, \$5,000.

HISTORY: Investigations have been made by the Bureau of Agricultural Engineering on 180-degree of three different sizes of channels of square and rectangular cross-section having two different radii, and the data obtained has been carefully analyzed. During the fiscal year 1934 investigations of the losses in bends of circular cross-section, 6 inches inside diameter were determined. One set of tests covered the standard 90-degree ell of standard radius. Other tests covered bends of various shapes.

The results to date reveal much valuable information of use in designing curved open channels and piping systems, that will, when practically applied, materially increase the efficiency of drainage pumping plant and other operations involving the use of pipes or channels having numerous bends.

DATE EFFECTIVE: July 1, 1934.

APPROVED:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 35

RESEARCH PROJECT NO.:

APPROPRIATION SYMBOL: 7000-2

PROGRESS REPORTS REQUIRED: January and July.

TITLE: Investigations of Farm Land Development.

LEADERS: George R. Boyd, N. A. Kessler.

OBJECTS: To determine the benefits to be received by the application of engineering science to the development of agricultural land and the perfecting of methods or equipment to be used in such developments.

PROCEDURE: Cooperative studies of methods of clearing land of brush, stumps, and stones have been conducted in Minnesota for the past four years. During the fiscal year 1935 it is planned to prepare final reports on the cooperative work conducted in Minnesota, to cooperate with the Bureau of Agricultural Economics in the land use study of certain areas in northern Minnesota, and to continue farm development studies in Minnesota and elsewhere.

The farm development studies are made in cooperation with State Experiment Stations and Agricultural Colleges. The plan contemplates a study of a number of farms typical of a section or State; the development of a balanced farming program which includes crops, livestock, machinery, buildings, and field improvement for each farm; and a determination of the benefits which will be received by the landowner when the plan is put into effect. The surveys and maps, which show all the physical features affecting the farming program are made by the Bureau of Agricultural Engineering. All cooperators unite in working up the farming program, and the benefits are determined by a study of the farm accounts when and as the suggested improvements are made by the landowner. These accounts are kept by the farmers under the direction of the cooperators.

COOPERATION: Formal: University of Minnesota; Virginia Polytechnic Institute. Informal: Agricultural Engineering Department, Clemson College, South Carolina, and landowners.

LOCATION: In cooperating States.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering 1935, \$7,000.

HISTORY: The cooperative investigation of land clearing methods with the University of Minnesota was started in 1927 and has been continued until this time. A bulletin entitled "Cost of Clearing Land in Minnesota", which covers one phase of this work, was prepared for publication by the University in 1934. Investigational work covering the development of individual farms was begun in 1930 when a survey and detailed plans for the improvement of 13 farms in North Carolina were completed. To date 85 farms in North Carolina, South Carolina, Virginia, and Minnesota have been surveyed and development plans have been prepared.

DATE EFFECTIVE: July 1, 1934.

APPROVED:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 31

APPROPRIATION SYMBOL: 3305

PROGRESS REPORTS REQUIRED: January and July.

TITLE: The Flow of Water in Ditches, Pipes, and other Irrigation Conduits.

LEADER: Fred C. Scobey.

OBJECTS: To determine the carrying-capacity elements of water conduits of various types and materials, in order that such conduits may be made large enough to convey the pre-determined quantities of water, assuring the individual farmer against loss of crop because of inadequate capacity; and small enough so that money is not wasted in excess construction. Being highly technical, these data are developed for engineers, acting on behalf of farmers as individuals or as organizations.

Present Objective.

To prepare material for revision of Department Bulletins 852 and 194, respectively, "The Flow of Water in Concrete Pipe" and "The Flow of Water in Irrigation Channels".

PROCEDURE: During the past fiscal year there was published Technical Bulletin 393, "Flow of Water in Flumes".

It is expected to continue this project for the fiscal year 1935, giving special attention to the revision of Technical Bulletins 49 and 150. There is constant demand for this information and much new and additional data are available on factors affecting the flow of water in these types of conduits. The importance of this work lies in the use of these data as the basis of design of conduits to meet specific conditions and without waste of material or labor in their construction. These series of bulletins have been extremely popular among engineers and those having to do with the design of irrigation conduits.

COOPERATION: Informal cooperation with individuals, irrigation enterprises and public utilities interested in the various phases of the project.

LOCATION: Chiefly west of the 100th meridian.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$6,000.

Cooperators furnish additional men, cars, trucks, carpenter work, etc. No money contributed.

HISTORY: The results of investigations thus far completed have been summarized in the following bulletins:

Department Bulletin 194, "Flow of Water in Irrigation
Channels"

Department Bulletin 376, "Flow of Water in Wood Stave Pipe"

Department Bulletin 852, "Flow of Water in Concrete Pipe"

Technical Bulletin 393, "Flow of Water in Flumes"

DATE EFFECTIVE: July 1, 1934

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 30

APPROPRIATION SYMBOL: 3302

PROGRESS REPORTS REQUIRED: July and January

TITLE: Silt in Streams and Reservoirs of Texas.

LEADER: H. J. Nickle

OBJECTS: Determination of the percentage of silt in the various Texas streams by weight and volume; of the distribution of silt in a cross-section of the particular stream under study; of the amount of sand and silt rolling along the bottom of the stream; and of the amount of silt actually deposited in reservoirs.

PROCEDURE: This project is in its eleventh year, the results of the first ten years' work having been published as Technical Bulletin 382, "Silt Load of Texas Streams".

In the past fiscal year the work was transferred from eastern to western streams in Texas. It is proposed to continue the work for the fiscal year 1935 without material change but probably extensive changes will be made in the following fiscal year.

This work was under the direction of Mr. O. A. Faris who was granted leave of absence on January 1, 1934 and was succeeded as leader on April 1 by Mr. Harry Nickle.

Data on the silt load of any stream is particularly apropos at this time and in further consideration of the erosion problem and methods for its prevention.

COOPERATION: State of Texas, through its State Board of Water Engineers.

LOCATION: Throughout central and western Texas.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Estimated at \$2,800 per annum by the Bureau of Agricultural Engineering, and the same amount by the Board of Water Engineers.

HISTORY: No similar study has been made in Texas or in the immediate vicinity of this field, but a basis upon which to found the Texas study has been developed from the studies the Division has made in California, Arizona, and Nevada in determining the silt content of

the Colorado River in these States, and the deposit of silt in reservoirs, canals, and on agricultural lands in Arizona and California. Technical Bulletin No. 67 - "Silt in the Colorado River and its Relation to Irrigation", a report of all the work done on the Colorado River of Arizona, Nevada, and California, was published in 1928.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 29

APPROPRIATION SYMBOL: 3301

PROGRESS REPORTS REQUIRED: January and July.

TITLE: Design and Invention of Apparatus.

LEADERS: R. L. Parshall and others of the Division.

OBJECTS: Devising of instruments and apparatus when none are available adapted to the requirements of irrigation and western drainage work on farms.

Study of commercial types of hydraulic instruments and apparatus with a view of improving their usefulness in irrigation.

PROCEDURE: During the past fiscal year the following reports were prepared: "Factors Affecting Accuracy of Current Meters", published in Mechanical Engineers Journal; "The Rating and Use of Current Meters", Colorado Technical Bulletin 3; and "Ventura Tube and Riffle Deflector Sand Trap", a mimeographed release.

\$8,000 from P.W.A. was made available for the installation of a field laboratory in the Imperial Valley of California. The first installation of this work was completed May 1, 1934.

During the fiscal year 1935 additional experiments will be conducted and different set-ups of the trap tried out. It is expected the work will be completed about January 1, 1935. This work is in cooperation with the Bureau of Reclamation, which bureau contributes \$2,500 to the operation of the sand trap.

It is very probable that, as a result of the tests made in the Imperial Valley, additional laboratory tests will be undertaken at Fort Collins to complete the season's work.

COOPERATION: The Agricultural Experiment Station of Colorado.

LOCATION: Fort Collins, Colorado.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures for fiscal year 1935, \$5,500.

HISTORY: Improvements have been made in rating stations, calibration tanks, surface water recorders, weirs, hook gages, rating flumes and current meters.

The new designs include an evaporimeter, hook gage, water registers, division flume, short box flume, Parshall measuring flume, and current meter.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.
BUREAU PROJECT NO.: 28
APPROPRIATION SYMBOL: 3206
PROGRESS REPORTS REQUIRED: July 1, 1935.
TITLE: Storage of Water Under Ground.
LEADER: A. T. Mitchelson.

OBJECTS: To determine the rate of percolation of water through the various types of soils prevailing in the areas where water-spreading is feasible; to determine the effect of temperature of soil, water, and air on this rate; to ascertain by experiments whether or not the native vegetation on these areas is beneficial through stimulation of percolation due to root action; by experimenting with plots over ascending and descending water tables, to determine what effect the fluctuating water table has on the rate of percolation, and when the soils refuse further charge; to learn as much as possible about movement of water, laterally and vertically, through these types of soil and to what extent silty water affects percolation.

PROCEDURE: We have just completed three years of work on this project but during the past fiscal year the program was greatly enlarged as a result of C.C.C. operations in southern California. Some 1500 miles of distributing channels for water spreading have been provided. We have installed water measuring devices upon about 15 or 20 of the main diversion works. We have also installed an additional spreading ground of the basin type on the River Sans near Santa Ana. This is a third basin supplementing two others now in operation by the water company. We have installed water measuring devices and recorders on these three spreading grounds.

As a result of our four years of activity on water spreading, the area devoted to that purpose in southern California has increased many fold and this year it has become a regular part of the flood control program of Los Angeles County. Further, as a result of our studies, spreading grounds are left in their natural condition rather than having the surface disturbed and the vegetation removed, thus saving very large expense in the preparation of these spreading grounds. Several hundred thousand dollars have been spent during the past year and a half by both the county and city of Los Angeles in purchasing spreading grounds.

For the two-year period ending July 1, 1935, the County of San Bernardino and the State have made available \$10,000 to be used in experimental work to supplement our Bureau funds and in

addition to C.C.C. funds. Our fund has also been further increased to the extent of \$13,500 for eight water spreading units in southern California, in the Santa Clara Valley, and at Mojave. It is expected that these funds will be expended by January 1, 1935.

It is proposed to prepare and publish a progress report during the winter of 1934-35.

For the present fiscal year it is proposed to continue our studies using as a laboratory, works constructed during the past fiscal year with P.W.A. funds.

COOPERATION: Formal and informal cooperation with other branches of the Federal Government, various State governments, educational institutions, municipal and local bodies.

LOCATION: Throughout irrigated West, principally in Arizona, California, Oregon, Texas, and Utah.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1934.

PROPOSED EXPENDITURES: Fiscal year 1935, \$6,000.

HISTORY: As far as is known, the first comprehensive attempts at conservation of storm waters, by spreading over gravel cones, were made in southern California about twenty years ago, and in 1912 to 1916 there were well developed small diversions, carrying small quantities of water taken out of San Antonio Creek, Santa Ana River, Santiago Creek and Whitewater River. As a result of the interest developed at that time, a cooperative report was issued by the California State Department of Engineering on Conservation and Control of Flood Water in Coachella Valley, California, the data having been gathered by this Bureau.

Since that time the increasing scarcity of irrigation water has made this matter one of primary importance to irrigation farmers.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 43

APPROPRIATION SYMBOL: 3208

PROGRESS REPORTS REQUIRED: January and July.

TITLE: Drainage of Irrigated Lands.

LEADERS: W. W. McLaughlin and J. C. Marr.

OBJECTS: To make a broad study of the drainage of irrigated lands, and to ascertain the present status of both district and individual drainage for the purpose of determining: (a) the extent of drainage, (b) the need for drainage, (c) the present engineering practices, (d) why some systems have failed while others succeed, (e) methods of operation and maintenance, (f) costs of drainage, (g) drainage for alkali removal and control, and (h) to what extent lack of drainage contributes to failure of irrigation enterprises and to what extent is it responsible for the land being submarginal.

PROCEDURE: Specific features will be taken up and made the basis for reports or manuscripts for publication.

It is suggested, first: a study of drainage for alkali removal and control. The principal work will be a field study of existing installations to obtain data on: (1) condition of land before drainage, (2) plan of drainage with cost, (3) effectiveness of drains, (4) nature of alkali present, (5) alkali in irrigation water supply, (6) specific alkali treatments in connection with drainage as: (a) chemical, (b) cultural, and (c) irrigation.

COOPERATION: None.

LOCATION: Throughout irrigated area.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures, fiscal year 1935, \$5,000.

HISTORY: A great deal of work has been done by this Bureau on the drainage of irrigated lands but nothing has been done for several years past.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 42

APPROPRIATION SYMBOL: 3207

PROGRESS REPORTS REQUIRED: January and July.

TITLE: Use of Sewage in Irrigation.

LEADERS: W. W. McLaughlin, and Wells A. Hutchins.

OBJECTS: To determine the effectiveness and limitations in the use of sewage for irrigation in the western States. There are several areas throughout the West where sewage is being used for the irrigation of crops. In some instances the sewage is rectified and in others it is not. As a source of water supply sewage is going to play a more and more important part and in these years of drouth there will be insistent agitation for the use of such water.

PROCEDURE: The procedure will be to visit areas where sewage is being used to learn the conditions of its use and the results of its application.

COOPERATION: None.

LOCATION: Throughout the seventeen western States.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures for fiscal year 1935, \$4,000.

HISTORY: Although considerable work has been done on the use of sewage for irrigation in the eastern States, no general studies have been made of this subject in the West.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 41

APPROPRIATION SYMBOL: 1083

PROGRESS REPORT REQUIRED: January and July

TITLE: Japanese Beetle Control Machinery

LEADERS: R. B. Gray, R. M. Merrill, Frank Irons

OBJECTS: To devise mechanical methods effective in combating the Japanese beetle by:

1. Altering existing equipment.
2. Devising new equipment.
3. Working out attachments.

PROCEDURE: 1. Study field and soil conditions and usual control practices in badly infested Japanese beetle areas.

2. Test out commercial types of machines for pulverizing soils, which give promise of destroying or injuring larvae.

3. Make any alterations on commercial machine or develop, if necessary, special equipment for effective control.

4. Test out commercial spray machines with a view to causing such improvements to be made as will affect control.

5. Devise an effective method of applying soil insecticides and mixing same into roots of nursery stock.

6. Devise an effective method of applying dust to corn.

7. Devise a mechanical method for making grub surveys preliminary to making rotary tillage machinery tests.

COOPERATION: Bureau of Entomology, with informal cooperation of New Jersey, Pennsylvania, implement and machinery manufacturers, nursery men and farmers.

LOCATION: New Jersey and Pennsylvania.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, 1935 \$2,000
Cooperators, 750

HISTORY: The Japanese beetle was first discovered in the United States in 1916 and has greatly increased in numbers since that time. The area of continuous infestation is estimated to cover over 7,000

square miles and includes practically all of New Jersey, Eastern Pennsylvania, Northern Delaware, with areas of infestation in New York, Connecticut, Rhode Island, Massachusetts, Maryland, Virginia and the District of Columbia. In 1932 traps placed outside of this area resulted in the discovery of infestations at points in Maine, Vermont, Ohio, Michigan, West Virginia, North Carolina and South Carolina.

The insect is destructive in both the adult or beetle stage and the worm or larval stage. Spraying for the adult stage has proven somewhat effective in infested shade and fruit trees, probably not so much from direct killing as from the repellent action. In the larval stage where turf is infested, dusting of the surface or mixing the poison in the soil is quite effective. The use of soil insecticides is quite expensive.

The past year preliminary tests of several types of rotary tillage machinery have been conducted and have indicated a possible control method which causes mechanical injuring of the larvae by the revolving cutters of the rotor. Further tests are to be conducted and alterations of equipment details are to be made this year with a view to increasing its effectiveness.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 40

APPROPRIATION SYMBOL: 1070

PROGRESS REPORT REQUIRED: Semi-annually.

TITLE: Power and Machinery.
Sub-project: Power and Machinery in Agriculture.

LEADERS: R. B. Gray, W. M. Hurst, L. M. Church

OBJECTS: Revision of Miscellaneous Publication 157, Power and Machinery in Agriculture:

- a. To show the influence of mechanical power and modern machinery on labor requirements and crop production.
- b. To show some of the factors affecting the utilization of power, labor and equipment on farms.
- c. To show the principal sources and amount of power used on farms.
- d. To show the distribution of power units and machinery used on farms by geographic areas.

PROCEDURE: Department, State, and other authentic publication and available records on power, labor and machinery, and material from the 1935 census of agriculture will be assembled, studied and compiled. The data will be presented for publication as a revision of Miscellaneous Publication 157, Power and Machinery in Agriculture.

COOPERATION: None.

LOCATION: Washington, D. C.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935, \$1,000.

HISTORY: Department Bulletin 1348, An Appraisal of Power used on Farms in the United States, published in February, 1926 was the first bulletin issued by the Department which indicated the magnitude and trends in the development and use of power and machinery in agriculture. This was followed in April 1933 by Miscellaneous Publication 157, Power and Machinery in Agriculture, based largely on the 1930 census. Both bulletins had a wide circulation as shown by the large number of references made to them, both as citations and reproductions of certain parts, by

agricultural writers. The greater part of the information contained in these publications is out of date and additional information will be made available in the 1935 census of agriculture.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 39

APPROPRIATION SYMBOL: 5205

PROGRESS REPORTS REQUIRED: Semi-annually.

TITLE: Improvement of Farm Buildings.
Sub-project - A Study of Farmhouse Equipment.

LEADERS: Wallace Ashby and A. H. Senner.

OBJECTS: The objects of this study are to test the efficiency and operating characteristics of equipment used in farmhouses for heating, lighting, water supply, refrigeration, cooking and similar purposes.

PROCEDURE: Laboratory tests will be made of as many types as possible of commercial equipment used for the purposes named above. Particular attention will be paid to new developments which give promise of replacing older types of equipment, such as the modern oil burner units and the new combination house heater and cooking stove.

Tests of electric cooking, water heating, and refrigerating equipment will be made in cooperation with the Bureau of Home Economics. Results of these studies will be prepared for publication in bulletin form.

COOPERATION: Bureau of Home Economics, U. S. Department of Agriculture.

LOCATION: Washington, D. C.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Bureau of Agricultural Engineering, \$3,000

HISTORY: Tests of household equipment have been conducted by this Bureau for several years prior to 1925. Technical Bulletin 109-T, A Study of the Oil Burner as Applied to Domestic Heating, now out of print, and Department Circular 405-C, The Domestic Oil Burner, have been very favorably received and are still in great demand, and have added materially in establishing the reputation of the Bureau in these matters. During the past two years tests of vaporizing oil burners and of cooking ranges have been made and the re-

sults prepared in manuscript form for publication. As stated above the setup of the Electric Home and Farm Authority to finance purchases of certain types of equipment and the prospects that other types of equipment may later be handled in this manner makes it particularly desirable to secure authoritative information regarding the performance of the various types of equipment on the market.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering.

BUREAU PROJECT NO.: 38

APPROPRIATION SYMBOL: 2137

PROGRESS REPORTS REQUIRED: January.

TITLE: Maintenance of Drainage Channels.

LEADERS: Lewis A. Jones and W. D. Ellison.

OBJECTS: To secure, develop and make available information relating to the most efficient methods of maintaining drainage channels of various sizes in different types of soil and with various kinds of vegetative growth in the channels.

Investigations relating to the hydraulics of drainage channels have developed the fact that proper maintenance is essential if the channels are to retain the capacity for which they were designed. Measurements show that where maintenance is not practiced, channel capacities, in a few years, are frequently reduced to less than half the capacity existing at the time the channel was constructed. This results in poor drainage and frequently loss of crops in areas where large expenditures have been made to obtain good drainage. The purpose of this project is to develop economical methods of maintaining channels so that landowners can, by proper maintenance, receive full benefit from the funds expended in constructing drainage channels. The Bureau of the Census, in its 1930 census of drainage, (Preliminary Announcement) shows that there were 130,457 miles of open ditches in organized drainage enterprises in 1929. This is in addition to the thousands of miles of open ditches on individual farms lying outside such enterprises.

PROCEDURE: Experiments will be conducted on drainage channels of various sizes in soils of different types. The channels will be cleaned out and maintained by such methods as - hand labor, machinery of different kinds, explosives, burning, poisoning, etc. A detailed record of the effectiveness and cost of each method will be kept and a report prepared giving the results of the investigations.

During the fiscal year it is proposed to start experiments on the ditches of the Little River Drainage District located in southeastern Missouri. Clean out work will be done with machines, hand labor, explosives, team and scraper, and some tests will be made with the use of poison to kill willows and other vegetation.

COOPERATION: Little River Drainage District of Missouri.

LOCATION: Southeastern Missouri.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering.

PROPOSED EXPENDITURES: Anticipated expenditures for the fiscal year 1935:

Bureau of Agricultural Engineering	\$3,000
Little River Drainage District	1,500

HISTORY: In 1917 the Division of Drainage, Bureau of Public Roads, conducted investigations on maintenance of open ditches in North Carolina by hand labor and issued a mimeographed report on the work. In 1930 the Division, in cooperation with the Department of Agricultural Engineering, Ohio State University, and the E. I. du Pont de Nemours Company of Delaware, conducted a limited number of experiments with the use of explosives in cleaning out ditches and issued a mimeographed report covering the work. In 1931 and 1932, investigations relating to the maintenance of small drainage ditches was carried on in the sandy soils of Kent County, Delaware, by the Division in cooperation with the Delaware State Highway Department. A report of this work has been made. Some of the manufacturers of explosives have experimented with the use of explosives in maintenance work. No comparative study of the various methods of maintaining drainage channels, such as is contemplated in this project, has been made.

DATE EFFECTIVE: July 1, 1935.

Approved:

S. H. McCrory,
Chief of Bureau.

PROJECT STATEMENT

BUREAU: Bureau of Agricultural Engineering

BUREAU PROJECT NO.: 27

APPROPRIATION SYMBOL: 3203

PROGRESS REPORTS REQUIRED: January and July..

TITLE: Pumping for Irrigation.

LEADER: Carl Rohwer.

OBJECTS: To gather data pertinent to the practical and economic phases of pumping for irrigation, including the mechanical units, the wells, the equipment, the method of installation, the assembled plant and the efficiency of the various units. It is also proposed to compile all available information on methods and cost of well drilling and the numerous factors influencing them such as relation of diameter of casing to yield, various types of casing, etc.

PROCEDURE: This project was set up in 1932 with Carl Rohwer as leader. It was proposed to get out a series of bulletins dealing with various phases of pumping. The first subject selected was to be the well and its equipment.

During 1933 information has been collected by personal visits to California, Utah, Nebraska and Colorado. Data previously secured by other employees were also assembled.

Due to funds being made available for sand trap laboratory in the Imperial Valley, it was necessary to assign Mr. Rohwer part time, to the project on design and installation of apparatus during 1934.

A manuscript is about completed dealing with the well and its equipment for pumping, and will be completed early in the fiscal year 1935. In the meantime other data are being collected dealing with the pump and other mechanical units. It is proposed to continue this project and give special attention during the next fiscal year to mechanical units of the pumping plant with especial consideration of the design of pumping units to meet definite conditions.

COOPERATION: State Agricultural Experiment Stations and other Federal, State, and private agencies.

LOCATION: Territory west of the 97th meridian.

LEGAL AUTHORITY: Appropriation, Bureau of Agricultural Engineering, 1935.

PROPOSED EXPENDITURES: Anticipated expenditures for fiscal year 1935,
Bureau of Agricultural Engineering, \$4,000.

HISTORY: At various times for years past this Division has made individual studies of special phases of this project and the results published.

DATE EFFECTIVE: July 1, 1934.

Approved:

S. H. McCrory,
Chief of Bureau.